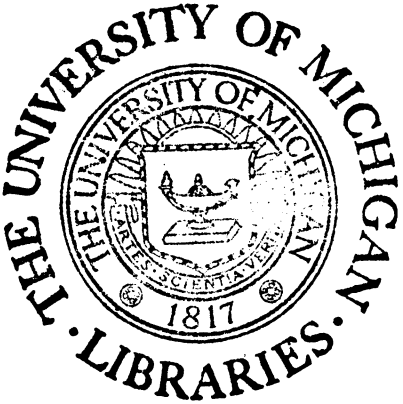
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By STANTON YOUNGBERG, *Director*

CROP CONDITIONS [1]

Man and Nature combined this year's efforts and gifts to bring about the most successful agricultural year the country ever had.

Only two typhoons passed over the Islands, one during July 1926, that did little harm, but another, very destructive, in November of the same year, hit the southern region of Luzon. With this exception, the weather conditions were very favorable, as bright sunny days alternated with short periods of rains due to the presence of several typhoons that hovered near the Islands without touching them.

The usual diseases and plant pests due to the vast area of uncultivated lands and an exuberant jungle threatened the crops, but the combined efforts of the farmers and the personnel of the Bureau of Agriculture succeeded at least in considerably diminishing the damage done where it was not entirely prevented with the result that the farmers were able to obtain not only increases in the area planted to all their crops over the areas planted in the preceding year, with the one exception of abaca, but also made several crop records both in bulk and per unit area.

The prices paid were generally lower than those in the preceding year, but these were more than offset by the larger yields obtained. In fact the total returns from the leading crops of 1927 have never been exceeded except during the periods of inflated values in 1920.

PALAY (ROUGH RICE)

During the last three years, rice had consecutively produced record crops. In 1925 the yield reached a higher mark than ever before registered, totaling 45,652,600 cavans. But this

[1] To conform to the crop seasons of the different products, the crop statistics given everywhere in this report are for the agricultural year ending June 30, 1927.

amount was exceeded in 1926, by 2,127,400 cavans, being 47,780,000 cavans, and in 1927 there was a further rise to 49,946,400 cavans, an increase of 4 per cent over the crop of 1926 and 9 per cent above that of 1925. There were, it is true, larger areas planted, at least during the last two years, to partly account for these substantial increases, but favorable weather and better farming systems contributed in no small measure to this success, for the yields per hectare in 1925, 1926 and 1927 were 26.46, 27.21 and 27.64 cavans, respectively, against 25.09, the annual average for the five years preceding 1925.

The area planted to rice was 1,725,500 hectares in 1925, 1,755,920 in 1926, and 1,807,060 in 1927, while the annual average for 1920–24 was 1,646,700 hectares.

The prices paid for these crops did not change materially during the three years mentioned, for while the average during 1925, was ₱4.20 per cavan, that for 1926 was 7 centavos higher and that for 1927 was 18 centavos lower; and the total values of the crops were ₱192,179,270, ₱204,051,110 and ₱200,970,720, respectively.

The interesting feature of the progress registered by this crop is the fact that the country is steadily becoming more nearly self-supporting as regards its chief article of diet; for the large quantities of this staple that were annually imported to make up for the local shortage have been steadily decreasing.

The following shows the annual production of palay and the importation of cleaned rice since 1910.

Years	Production *Cavans*	Importation *Cavans*
1910	18,859,090	3,431,760
1911	20,530,100	3,194,343
1912	11,622,470	5,235,778
1913	24,498,860	1,512,862
1914	22,736,810	1,685,591
1915	17,818,490	3,798,983
1916	20,878,860	3,301,488
1917	28,276,720	2,556,273
1918	35,795,050	3,195,331
1919	33,781,650	883,804
1920	36,343,810	1,344,945
1921	41,478,540	1,035,266
1922	43,436,830	735,563
1923	43,790,500	1,155,635
1924	41,570,700	2,627,979
1925	45,652,600	1,759,981
1926	47,780,000	1,225,807
1927	49,946,400	211,562

SUGAR CANE

With the sole exception of the 1925 record crop, the sugar harvest during 1927 was the largest ever registered.

There were 237,350 hectares put under cultivation in 1927 as against 231,840 in 1926 and 239,470 in 1925 and the yields were 10,434,910 piculs of sugar and 564,750 piculs of panocha in 1927, as against 8,195,370 and 516,020 piculs respectively in 1926 and 10,659,480 and 521,030 piculs respectively in 1925. There were slight decreases in the production of basi during the three years mentioned. In 1925, the yield was 4,315,210 liters, which dropped to 4,298,790 liters in 1926 and to 4,066,020 liters in 1927. The production of molasses did not change materially, totaling 4,833,860 liters in 1925, 5,935,540 in 1926 and 4,365,550 in 1927.

The ever-increasing number of sugar centrals in these Islands is placing this industry on a better basis and, of course, there is noted a remarkable increase in the yields of sugar per hectare. The average annual yield for 1910–19 when there were few centrals in these Islands was 31.40 piculs per hectare, while in 1923, it was 46.69; and 46.34 in 1927. Weather conditions during 1926 were not favorable, but still the yield was 37.57 piculs or 20 per cent larger than the average for 1910–19.

Prices for sugar were higher in 1927—₱10.38 as against ₱8.89 in 1926 and ₱10.06 in 1925—but lower for panochas—₱7.65 per picul as against ₱8.32 in 1926 and ₱8.39 in 1925.

Basi brought ₱13.71 per 100 liters in 1927, ₱15.36 in 1926 and ₱15.49 in 1925. Molasses was sold at ₱10.03 per 100 liters in 1927; ₱9.15 in 1926 and ₱9.11 in 1925.

The aggregate value of all sugar cane products totaled ₱113,591,090 in 1927 as against ₱78,401,990 in 1926 and ₱112,729,900 in 1925.

COCONUTS

Most substantial increases in yield during 1927 were registered by coconuts and coconut products. In fact the year 1927 was a record one for this crop.

The production of coconuts and copra is steadily increasing every year and the rate of increase seems certain to rise for there is a general tendency to extend the areas planted to coconuts, letting them encroach upon other crop areas, especially abaca, in view of the increasing demand for vegetable oils and the new uses found for copra and coconuts.

At the end of the agricultural year 1927 there were 94,877,740 coconut trees planted, 58,414,390 of which were in bearing, tuba being distilled from 455,000 and the rest being young, as against 91,908,700, 54,650,430 and 465,790 respectively at the end of 1926.

There were 1,800,027,000 nuts gathered, an 11 per cent increase over the number gathered during 1926, which was 1,627,379,000 nuts.

The making of desiccated coconut is a fairly new industry that is rapidly developing in these Islands, and this considerably increased the consumption of coconuts during 1927 over 1926. The number of fresh coconuts used for this industry and to eat during the year 1927 was 160,276,000 as against 148,759,000 in 1926, or an increase of 8 per cent.

There was, too, a remarkable increase in the production of copra of from 5,780,700 piculs in 1926, to 6,484,750 piculs in 1927, or an increase of 12 per cent.

Coconut oil (home made) and tuba also registered increases of about 10 and 9 per cent respectively over the production of 1926. The figures for coconut oil and tuba were 1,973,710 liters and 107,772,910 liters respectively in 1927, as against 1,787,810 and 99,001,810 in 1926.

Except as for tuba, prices were lower during 1927. Coconuts sold at ₱3.84 per 100 in 1927 as against ₱4.17 in 1926. Copra brought ₱9.95 per picul in 1927 against ₱11.28 in 1926. Coconut oil sold at ₱0.44 per liter in 1927 but at ₱0.47 in 1926, and tuba at ₱0.097 per liter in 1927 against ₱0.092 in 1926.

The total value of coconuts and their by-products was ₱81,985,970 in 1927 and ₱81,369,370 in 1926.

ABACA

This valuable fiber plant showed during the year 1927 a reduction of 2 per cent in the area planted, of 5 per cent in the yield and of 10 per cent in the total value of the crops.

These losses were chiefly sustained in the old plantations of the Bicol region, Samar, and Leyte, where as a result the planters are seemingly losing their faith in the future of abaca and so directing their attention to the cultivation of other crops which promise better returns, like coconuts, sugar, and rice.

The total area planted to this fiber was 480,150 hectares in 1927, yielding 2,731,630 piculs worth ₱59,240,800. The corresponding figures for 1926, were 492,050 hectares with a production of 2,878,060 piculs valued at ₱65,724,830.

Prices also went down to an average of ₱21.69 per picul for 1927 as against ₱22.84 for 1926.

CORN

During the year 1927 the largest area ever registered for this crop was planted, and as weather conditions were favorable and the other usual calamities in the form of pests and plant diseases were greatly reduced, the largest crop of corn the Islands ever had was obtained.

The total area planted in 1927 was 561,430 hectares, as against 533,570 hectares in 1926, or an increase of 5 per cent and the production was 8,384,710 cavans as against 7,899,730 cavans in 1926, or an increase of 6 per cent.

The prices paid during the year were lower, the average being ₱4.14 per cavan of shelled corn, when in 1926 it was ₱4.73. Accordingly the total value of the 1927 crop was smaller, or ₱34,697,470 as against ₱37,370,300 in 1926.

TOBACCO

Tobacco registered substantial increases both in the area planted and in production. There were 83,970 hectares planted against 74,790 in 1926, or an increase of 12 per cent, while the production of tobacco leaf amounted to 1,091,660 quintals in 1927 against 988,010 quintals in 1926, or a 10 per cent increase. There was no change in price. Both years' tobacco leaf was sold at ₱12.10 per quintal.

The total crop in 1927 was sold for ₱13,180,830 and that in 1926 for ₱11,943,460.

MAGUEY

This fiber showed an increase of nearly 2 per cent in the total area planted in 1927 over that of 1926 but the production was considerably less—21 per cent.

During the year 1927 there were 34,000 hectares planted yielding 315,470 piculs valued at ₱3,838,490, while the corresponding figures for 1926 were 33,350 hectares, 400,400 piculs and ₱5,036,250.

CACAO AND COFFEE

There were very slight increases in the total number of cacao and coffee trees planted and in the yields in 1927 over those of 1926.

There were 2,042,500 cacao trees under cultivation at the end of the agricultural year 1927 of which 1,179,400 were in bear-

ing, yielding 1,089,100 kilos, which were sold at ₱1,127,600 at the rate of ₱1.03 per kilo. The corresponding figures for the year 1926 were 2,029,400 trees and 1,171,900 trees and 1,082,700 kilos at ₱1,119,400.

There were 2,533,700 coffee trees planted at the end of the agricultural year 1927, of which number 1,461,000 produced 1,209,800 kilos of coffee which at ₱0.69 per kilo brought ₱840,800. The figures for 1926 were 2,515,600 and 1,455,900 trees and 1,207,300 kilos which at ₱0.69 per kilo sold for ₱836,700.

LIVESTOCK

In view of the impossibility of completing the compilation of the data for the year 1927 in the short period elapsing between the end of the year and the date fixed for presenting this report, the figures given for animals are one year behind, that is, they are for December 31, 1926.

In spite of the fact that the minor animals like hogs, goats, and sheep registered decreases in the rate of birth, there was a general increase in the number of all animals during the year 1926.

The birth rates for carabaos, cattle, and horses increased .75 per cent, 2.85 per cent, and .43 per cent, respectively, while those for hogs, goats, and sheep fell 5.80 per cent, 6.34 per cent, and 3.49 per cent, respectively.

During the year there was also a general improvement as to the diseases, for the rate of mortality for all animals decreased .23 per cent for carabaos, 0.04 per cent for cattle, .17 per cent for horses, .33 per cent for hogs, .99 per cent for goats, and .29 per cent for sheep.

There was an increase in the consumption of meat of carabaos, cattle, and horses by .48 per cent, .60 per cent, and .38 per cent, respectively, but a decrease of .49 per cent for hogs, .66 per cent for goats, and .45 per cent for sheep.

PLANT INDUSTRY DIVISION

The division's activities, as usual, consisted mainly of plant investigational work on corn, rice, tobacco, sugar cane, abaca, fruit trees, and minor crops.

Corn.—At Lamao, the corn variety test showed the Calamba Yellow and Baluga Yellow to be the best of 12 yellow varieties and the Moro White, the Siamsiam White the best of 12 white varieties. Average yields: 25.92, 21.96, 19.52, and 17.10 cavans

per hectare, respectively. The best strain of Calamba Yellow gave 48.11 cavans per hectare against 38.02 cavans of check in the ear-to-the-row test. Considering the cost the best fertilizers were found to be bone meal, sulphate of potash, guano, barn manure and the complete fertilizers containing 3 per cent N., 1.5 per cent K_2O, and 7 per cent P_2O_5. Pop corn varieties under test are becoming well acclimatized. In the corn inbreeding test at the Ilagan Tobacco Experiment Station the White Sweet was found best of five varieties. Degeneration took place in the size and fullness of the ears as a result of the second year test, it was observed.

Forage crops.—The tests started last year were continued. Planting on paddy soil, the Balili, Buñgalon, and Barit were the best; of the nonirrigated forage crops introduced from abroad the Napier, Merker, Trinidad, and Guinea grass gave the most roughage.

Tobacco. Wrapper tobacco test (Ilagan Tobacco Experiment Station).—The 43-Philippine Sumatra led with 35 per cent wrapper. The 65-Havanensis gave 15 per cent, and the 18-Philippine Florida-Sumatra gave 15 per cent. Total yield of wrapper, filler, and binder per hectare: 1,690 kilos, 1,325 kilos, and 1,649 kilos, respectively.

General filler varieties test (Ilagan Tobacco Experiment Station).—The 6-Pampano No. 2, 2,887.50 kilos per hectare. The 10-Repollo, 2,607 kilos per hectare, and two other varieties gave good yieds.

General fertilizer test.—Sulphate of potash at the rate of 75 kilos of K_2O per hectare gave the highest yield and the ammonium sulphate and superphosphate at the rate of 20 kilos N. and 30 kilos of P_2O_5, respectively, the lowest. The variety used was the 43-Philippine Sumatra.

Spacing and hybridization experiments were carried on and the curing studies pursued.

Seasonal planting test.—The November crop gave the highest percentage of wrapper, 15 per cent and the January planting, 8 per cent. The March crop was stunted.

Growing tobacco between *Tephrosia candida* at the Sarunayan Tobacco Experiment Station yielded very fine, elastic and mostly "claro" wrapper; without shade, the leaves were fairly fine but inclined to be "colorado claro."

Lowland rice.—Seventy varieties were tested at the Rosales Rice Experiment Station and of the late varieties Murmuray yielded 87.5 cavans per hectare, Daluson, 78. Bacal and Ca-

yading each 77.5, and 5 others over 70. Among the early maturing varieties Macanening yielded 60 cavans, Cagayanes 59, and Mararniag 51 per hectare, while of the glutinous rice, Bal-latinao produced 68, Yucan 56 and Enero 50 cavans per hectare. At Alabang 27 varieties were tested and Inachupal-I proved to be the heaviest yielder with 60.29 cavans per hectare, but Lubangluay, the poorest, gave only 5.84 cavans. Of the medium late varieties, the Mancasar strain No. 3 led with 77.69 cavans, and the highest of the late varieties was the Kinalibo-II with 68.15 cavans. The trials with rice varieties from Spain, Japan, and the United States failed to give satisfactory results.

Fertilizer test on rice.—At Rosales, ammonium sulphate, superphosphate and ammophos on Sipot rice—300 kilos per hectare—brought the yield up to 66, 62, and 60 cavans per hectare, respectively, 44 cavans more than the control plot. Ammonium sulphate and copra meal gave the most satisfactory results at Alabang.

Testing for flood resistant varieties of rice.—The Pangasinan bearded lowland rice varieties, especially Bacal and Mandegoring showed considerable resistance to flood at Rosales; and at Alabang, Mangasa and Madaling Araw proved best for emergency planting after floods.

Planting mongo and cowpeas after the harvest increased the second crop of rice by 27 per cent, and 17 per cent, respectively, in an experiment using the "Cruz" variety.

"Palagad" or dry season rice.—Sipot topped the list with a yield of 69.78 cavans per hectare and Dinagat came second with a yield of 52.61 cavans at Alabang. Of the 10 varieties milled, Khao Bai Sri was classified as "Superior."

Upland rice (Lamao Experiment Station).—Ninety-three varieties were planted June 22 and 23, 1927—rather late—but gave very good crops, Kinastila leading with 63.13 cavans per hectare. 3 and 4 seeds per hill planted in upland rice gave the best results.

Sugar cane. Variety tests No. 1–3, plant cane (La Carlota Sugar Cane Experiment Station).—Of the 15 varieties, Java-247 gave the highest yield in sugar per hectare, 151.23 piculs; Badila 120.04 piculs; Luzon Purple 115.67 and New Guinea 24-A, 113.48 piculs. In the second year test of the 22 new varieties, Java-213 produced 164.4; Luzon-4, 147.96 piculs; C. A. C., 89; and C. A. C., 91. In the third test only 7 varieties were used L. C. S. C. 2/4 leading with 121.58 piculs.

Variety test No. 4 (Ratoon).—Thirteen varieties were compared, Hawaii-109 led with 129.36 piculs and New Guinea 24-A followed with 127.91 piculs. The others gave less than the check "Negros Purple" which produced 103.85 piculs of sugar.

Fertilizer test on sugar cane.—Both commercial and home-mixed fertilizers were used. Brand No. 3 of the former proved best, giving an increase of 29.19 per cent over the control. Of the home mixed fertilizers mixture B containing 10 per cent N. from ammonium sulphate, 6 per cent P_2O_5 from basic slag, and 2 per cent K_2O from sulphate of potash gave 27.82 per cent increase over the control.

Citrus.—Continued cover-cropping with *Tephrosia,* cacahuate, and patani gave increases in yields of some 86 to 48 per cent for Batangas mandarin-orange trees over the system of temporary cover-cropping. A series of fertilizer tests with ammonium sulphate and copra meal, supplemented with lime, gave very good results.

The rejuvenation experiment was continued at Tanauan. A number of good strains being advantageously used in top-working old and otherwise weak mandarin orange trees. Preservation and etherization experiments were also tried.

Coffee.—The fertilizer test with Excelsa coffee trees at Lamao was continued, as were the variety tests. Excelsa and Liberian coffee again proved to be the best yielders.

Mango.—Smudging tests were continued at Lamao with success and in Muntinlupa, Rizal. Of 95 trees smudged in November, 80 flowered.

Variety tests.—There are 849 mango plants in the orchard at Lamao among which are 97 inarched and 40 seedling Indian mangoes.

Semi-Temperate fruit trees.—Three varieties of apples, and the cherimoyas, loquats, olives, kaki, Moon pecans, Green Ischia and Brunswick figs and grapes are thriving quite well in the Baguio Acclimatization Station.

Three varietes of papaya are being raised at Lamao, the Hawaiian leading. Twenty-two varieties of bananas are being tested but it is too soon to report on these.

Root crops.—Of the 27 varieties of sweet potatoes at Lamao with which a test has been continued for yield, the three best were Mintal, American Large White, and Kinalamias.

Variety tests with ube, tugue, yautia, and gabi were continued.

Pineapples.—In the fertilizer test with pineapple the yields were in the ratio of 7 to 4 as compared with those of the check crop. Hybridization tests were continued and the crosses planted for further study.

Vegetables.—Variety tests were continued with tomatoes, 21 varieties being used in Lamao; and in Baguio, Irish potatoes, chick peas and *Aralia cordata*, a Japanese vegetable, are doing well.

At the Lamao Experiment Station, there are 2,125 miscellaneous tropical trees, consisting of 320 varieties and 200 species. Eight trees flowered for the first time but only two produced fruits.

Rubber.—Tapping experiments were continued at the Baco Rubber Plantation in Mindoro and the half-spiral method of tapping from January to November, alternate daily, once a day, in the morning, was found to give the best results, 10.4 grams of dry rubber per tree, while at the Abucay Plantation, Bataan, 9.5 grams of dry rubber were obtained by tapping daily, alternate months.

Abaca. Guinobatan Abaca Experiment Station (test continued from 1926).—The computed yield of fiber per hectare for Maguindanao was 211 kilos; for the Lausigan, 205 kilos; Puti Tomatagacan, 183 kilos; but for six varieties there was less than 100 kilos and for one, Tañgoñgon, only 18.

Plots planted to suckers gave 6.2 per cent and 2.5 per cent more than those planted to rootstocks. Tests were made at the Guinobatan station with the "Benito" knives, which are numbered by the number of teeth to the inch.

Cultural and fertilizer tests were also tried. Cotton and kapok experiments were continued at Lamao. There are 14 grafted kapok trees and 17 budded. The scions are of Java kapok while the stocks are native. Of miscellaneous fibers there is one Pochote growing from 37 seeds received from the United States Department of Agriculture in 1924, but slowly, and there are five of Balsa and eight of Pochote from seed from Mexico in 1926, besides 20 of Malabulak.

Sugar-cane investigation in Mindoro.—Planting by machine at San Jose was found to cost ₱8 per hectare and cultivating, ₱3.

Coöperative work on rice in Mindoro.—"Ramai," according to tests made, seems capable of increasing the yields by over 100 per cent and "Apostol" has been found to increase the yield

25 per cent as compared with "Pinili" and "Diamante," two local standard varieties.

Miscellaneous investigations.—A coconut investigation was made on Guimaras Island in Iloilo; another on strawberries in Trinidad, Benguet. Observations as to the vigor, productivity, and susceptibility of naturalized Arabian coffee trees found in the Mountain Province and places ranging in altitude from 1,591 to 6,750 feet above sea level showed that Arabian coffee does best from 5,000 feet up to the last named altitude. Soil and fertilizer investigations were made, and 106 soil samples analyzed with the coöperation of the Bureau of Science.

Coöperative planting experiments on miscellaneous fruit trees were continued. Farm blasting and farm machinery investigations were also made. Two thousand one hundred and ninety-five (2,195) coöperators were added to the former number—2,661.

Seed and plant introduction.—Sixty species (some duplicates) consisting of 158 varieties were introduced for trial planting in the stations of the Bureau.

Seed and planting materials and other experiment station products.—For free distribution, for coöperative trial planting, for exchange purposes (with foreign governments, firms, institutions, individuals, etc.) and for sale, through the Agricultural Extension Division, seed and planting materials with a total estimated value of ₱32,160.98 were produced.

AGRICULTURAL EXTENSION DIVISION

This division extended the scope of its activities to cover three more provinces; Ilocos Sur, Occidental Negros, and Abra. On the whole the people's interest and appreciation seem to be increasing. More nurseries are opened and more plants distributed.

Over half a million fruit trees were planted as the result of the horticultural campaign.

Since the agents have been inducing the farmers to start private nurseries it is estimated that about 680,000 seedlings were propagated in this way.

The division distributed seedlings and plant materials from the Central Office, the Singalong Propagation Station, the insular nurseries in Lipa and Iloilo and through its field men. The Plant Industry Division also furnished part of the material. The total value of seeds and seedlings distributed by the Central Office and the Singalong station was ₱23,917.64.

Singalong Propagation Station.—The following shows the plants raised at the station and the disposal made of them:

Economic plants, balance from 1926	87,473
Economic plants distributed during 1927	60,379
Economic plants undistributed	109,273

Of those distributed 3,475 were grafted (mostly mango), 712 were budded and 479 were marcotted plants. The station made 746 shipments of seeds and plants.

Mangosteen.—The experiments on the asexual propagation of mangosteen were continued. Of 22 stocks grafted, 20 grew, but none of the 17 stocks budded.

Mushrooms.—Mushrooms were grown at the station but due to unfavorable conditions their growing was found not profitable enough.

Sweet corn.—Two varieties "Country Gentleman" and "Golden Bantam" are promising.

Lipa Demonstration Station.—Coffee and citrus were the principal plants propagated. 68,087 coffee seedlings were distributed and 136,036 were available at the end of the year. A portion of the station was transferred to an adjacent site.

La Paz Demonstration Station.—The station lost a great many plants during the flood of September 1927, which made it necessary to replant. In this station more success was obtained in the grafting of lanzones than in any other. Two hundred eighty-seven grafted lanzones were distributed. The total number of plants sold was 3,235, valued at ₱1,320.50; distributed free, 3,738, valued at ₱886.60; on hand, 5,133, valued at ₱1,413.22.

Provincial nurseries.—Two more provincial nurseries, one in Abra and one in Cagayan, were added to the 14 under the supervision of this division.

Municipal nurseries.—Eleven more municipal nurseries were added to the 19 already in existence.

Producers' associations.—In spite of the educational campaign for helping the associations already organized progress was slight, the general mass of the farmers being indifferent. The Siam-na-Pinagisa Poultry Producers' Association at Talipapa, Caloocan, Rizal, was discontinued. The Nemmatan Tobacco Producers' Coöperative Association harvested only 300 fardos of poor quality tobacco due to the inclement weather. But it also produced over 200 uyones of Inantipolo palay, a variety introduced by this Bureau; and constructed a poultry house, a nur-

sery, and a pig pen and got a pair of Barred Plymouth Rocks and a Berkshire boar from the Bureau.

Vegetable project.—The agents constantly encouraged the planting of vegetables, distributed seeds and taught proper cultural methods.

Poultry project.—The work of increasing and improving the poultry industry was continued. The agents caponized 3,774 chickens and treated 845 for various diseases.

Rice project.—During the year the division distributed 312.5 cavans of various varieties of palay including 131 of Ramai, 38½ of Apostol and others giving good yields. Two hundred twelve rice coöperators secured seeds from the Plant Industry Division and other sources through the agricultural extension agents.

Fertilizers.—The use of fertilizers has been so general and widespread this year that there are now fertilizer dealers in a number of towns.

Sugar-cane project.—Twenty-six thousand ninety-six (26,096) cuttings were distributed through the Central Office and 704,068 cuttings secured through the extension agents direct. The varieties were Badila, Cebu Purple, Negros Purple, Hawaiian-109, New Guinea 24–A, Barbados, Java No. 247, Mauritius No. 1900 and Pampanga Red and White.

Tobacco project.—As last year the division had four men in Isabela and three in Cagayan engaged in this work. Lectures and demonstrations were given and circulars and posters distributed and 171 farmers given tobacco seed. Less seed was distributed than in 1926 as many farmers had saved their own; and a number that had planted wrapper tobacco obtained fair results. One grower sold one of his 6 fardos at ₱15 a fardo while the current price of a quintal (2.5 fardos first-class tobacco or 5 fardos third class) was from ₱7 to ₱8. More tobacco curing sheds were built and more cleanliness practiced in general. Prices on the whole were lower than in 1926 so more people are inclined to plant less tobacco and more food crops.

Abaca project.—Abaca rootstocks of the varieties Tañgoñgon and Maguindanao distributed in the Bicol region last year made a fair start, especially the Maguindanao. Rootstocks of Maguindanao and Itom were also distributed in Cavite but neither variety is doing well. In the Cagayan Valley, where abaca has been reported as thriving for the last three years, suckers are

being planted as fast as they become available. The agents demonstrate the method of stripping abaca, a new thing there. The division, in coöperation with the Indang Farm School is conducting trial planting. Eleven resistant varieties are being tried with and without fertilizer.

Dynamiting.—In and around Manila the division has resorted to dynamiting holes for fruit trees with good results. Requests for this work increased very much, so two men were assigned thereto.

PLANT PESTS CONTROL DIVISION

For 1927 no administrative orders were promulgated by the Director of Agriculture, but on June 14 an order was issued under the provisions of Administrative Order No. 29, setting forth the conditions whereby plant materials may be permitted to enter the Philippines.

Contributions and gratuities.—Twenty-three thousand four hundred pesos (₱23,400) was allotted to the provinces from the contributions and gratuities funds of this division to assist them in the control of pests and diseases. At the end of the year there was a balance of ₱43,278.87 available for this work. Most of the collections were taken up in the provinces through the enforcement of Sections 14 and 15 of Act 2472 and special appropriations were made by the provinces themselves.

Provincial locust campaign.—Summarizing the work done for the control of locusts throughout the Islands, it is gratifying to note that the people, under the direction of the municipal and provincial officials, the Constabulary soldiers and locust inspectors, all worked energetically to save the crops.

Provinces infected with locusts during the year	18
Provinces freed from locust infestation during the year	12
Provinces still infested at the end of the year	6
Total number of municipalities infested during the year	134
Total number of municipalities freed during the year	108
Total number of municipalities still infested at the end of the year	26

Locust scouting.—Locust scouting was pushed energetically during the first nine months of the year, especially to free Bohol and Mindoro, which have been infested for the last five years and are the sources of infestation for the Visayas and Luzon. They were finally cleaned up about the end of April and May respectively.

Scouting work was done in the provinces of Bohol, Cagayan, Isabela, Mindoro, Mountain Province, Nueva Ecija, Nueva Viz-

caya, Negros Oriental and Tayabas. The expenses that were incurred in this work totaled ₱99,911.38. Two aeroplanes, costing ₱3,150 and ₱2,365, respectively, were used in Bohol. Because of overdraft in the locust scouting funds as provided by Act 5163, this division was obliged to gradually disband the personnel paid from this item from September 15 to December 15, 1927, when scouting was completely stopped.

SURVEY AND ERADICATION OF COCONUT BUD-ROT AND OTHER PESTS AND DISEASES OF COCONUTS

Inspection, field survey, extension and control work.—Most of the time and efforts of the members of the staff was as usual taken up attending to the numerous complaints about insects, pests and plant diseases from all parts of the Archipelago.

Entomological and phytopathological research work.—Both field and laboratory studies of the tobacco leaf folder, the most serious pest of tobacco seedlings in the Cagayan Valley were made, as also observations on the citrus leaf miner, the mango twig borer, the Mediterranean flour moth, the rice borers, the cabbage moth, diamond back moth, etc. Research work on diseases of abacá, bananas, Hevea rubber, rice and tobacco were the major activities.

Visiting scientists.—Among these was Dr. Shuta Kinoshita, chief entomologist of the Imperial Agricultural Experiment Station, Tokyo, Japan, who is chiefly interested in the parasites of the rice borers.

Abacá and banana diseases.—Since the publication of the Bureau of Agriculture Circular No. 190, the tentative conclusion has been reached that "bunchy-top" and "heart rot" of abacá are the same, the latter being the final stage. The primary cause of bunchy-top is now thought to be a filterable virus.

Variety tests showed that a number of abacá varieties were partially resistant and Canton and Pacol immune. The use of calcium phosphate or potassium sulphate fertilizers increased resistance to the disease, but fertilizers containing nitrogen only were not satisfactory. The aphid which transmits bunchy-top also appears responsible for the spread of banana bunchy-top.

Pineapple diseases.—Much attention was given to a serious pineapple fruitlet rot. The results have been submitted for publication in the Philippine Journal of Science.

Rice disease.—Field investigations were made of sclerotial stem rot and laboratory studies are in progress thereon.

Rubber diseases were found to be negligible.

Tobacco diseases.—Investigational work on tobacco diseases was limited to a bacteriological disease which appears to be wildfire. General field observations were made and laboratory study undertaken of a green spot on Sumatra wrapper at the Sarunayan Tobacco Experiment Station.

Coconut diseases (other than bud-rot), those of sugar cane, corn, rice, citrus, coffee and cacao and diseases of more or less importance of other fruits, vegetables and plants were attended to. One hundred thirty-four record pathological diagnoses were made.

Survey and eradication of abacá pests and diseases.—In Davao, this work was resumed in September and conducted in Tayabas during the early part of the year.

RURAL CREDIT DIVISION

Inspection and supervision.—The entire Archipelago was subdivided into 11 districts but two important districts have no permanent agents for lack of personnel.

New associations.—Three new associations were organized: San Remigio, Cebu; Catmon, Cebu; and Carmen, Cebu. The association of San Carlos, Pangasinan, was reincorporated with ₱15,000 capital.

This division could easily increase the present number of associations but refrains from doing so for lack of sufficient personnel to supervise them.

Collection of overdue loans.—Good results were obtained along this line. Some cases had to be taken into court but no sooner is one delinquent borrower sued than others pay their debts. As a rare exception, a number of delinquent borrowers tried to defy the authority vested in a duly elected board of directors in an association of Pampanga. In an illegal election they put in a new board of directors and by court proceedings tried to accuse the five honest directors. The case having been decided by the Court of First Instance in favor of the present administration was appealed to the Supreme Court.

THE ADMINISTRATION OF THE RICE AND CORN FUND

At the close of business, December 31, 1926, the amount of uncollected debts from the associations totaled ₱758,672.17.

Uncollected during 1927	₱130,303.87
Total loans renewed	750,131.04
Total loans granted (incl. additional loans)	138,845.00

Only six associations out of 244 that owed the Rice and Corn Fund were sued or threatened with suits; and out of these, six court cases only were formally presented, and even these associations paid their debts before the date of the trial came.

Progress during the year was, in many cases, satisfactory.

PROBLEMS YET UNSETTLED

Additional bonding of the municipal treasurers.—All municipal treasurers acting as ex-officio treasurers of the associations were additionally bonded in the Fidelity Fund.

Absence of authority to correct evils.—Where the supervisory authority of the Director of Agriculture has been recognized, this office has been able to get relatively good results; but where this Bureau was unable to exercise any control over the affairs of an association, it could only give advice.

A Philippine Rural Credit Paper.—A pamphlet has been prepared with this title which is a compilation of all rural credit laws, circulars, and forms.

ANIMAL INDUSTRY DIVISION

VETERINARY SECTION

Importation from foreign ports.—Two thousand one hundred eighteen cattle arrived at the port of Manila during the year, from Pnom-Penh, 8,319 from Australia, and 356 carabaos from Pnom-Penh; and 1,134 carabaos, 70 cattle, 3 hogs, and 5 other animals, entered the port of Iloilo.

Interisland shipments.—Fifteen thousand seven hundred thirty-eight cattle and 2,615 carabaos arrived at Manila from interisland ports, 3,454 cattle and 459 carabaos more than in 1926.

Inspection for which fees were collected.—A total of 152,849 animals of all kinds were inspected upon arrival at Manila, for which fees amounting to ₱20,401.70 were collected. Of these animals 120,797 were swine.

Postmortem inspection in Azcarraga Abattoir.—There were 131,171 animals of all kinds inspected, of which 129,786 were passed for food and 1,385 condemned. The number inspected included 115,678 swine.

Postmortem inspection in Pandacan Matadero.—One thousand seven hundred twenty-one animals were slaughtered at this matadero, 1 was condemned and 1,720 passed for food.

Postmortem inspection in Sisiman Matadero.—At Sisiman 7,966 Australian cattle were slaughtered and 62 were condemned and 7,904 passed for food.

COMBATING ANIMAL DISEASES

Rinderpest.—Three thousand thirteen cases of rinderpest were reported with 2,123 deaths.

Rinderpest cases and deaths by quarters

Period	New cases	Deaths
First quarter	786	500
Second quarter	918	705
Third quarter	948	654
Fourth quarter	361	264
Total	3,013	2,123

The provinces that suffered most were Ilocos Sur, Pangasinan, and Iloilo. The infection there remained over from the infection in 1926.

Anthrax.—Sporadic cases of anthrax occurred during the year in Bulacan, Cavite, Laguna, Nueva Ecija, Pampanga, Rizal, and Tarlac. The total number of cases and deaths were 327 and 301, respectively, representing a reduction of 323 cases, 301 deaths as compared with the cases and deaths registered during the previous year. Whenever an outbreak occurred vaccination of all the carabaos and cattle in the infected barrio was done. A total of 43,777 carabaos and 4,900 cattle were vaccinated.

Hemorrhagic septicemia.—The disease occurred during the year in Albay, Cebu, Ilocos Sur, Masbate, Misamis, Occidental Negros and Samar, 596 and 532 deaths being recorded, against 697 cases and 637 deaths the past year.

Surra.—One hundred forty-three cases were recorded.

Foot-and-mouth disease.—There was an extensive outbreak of this disease with a total of 24,232 cases but only 375 deaths. About 95 per cent of the cases were among carabaos.

VETERINARY RESEARCH LABORATORY

Rinderpest vaccine.—In the preparation of rinderpest vaccine, 414 head of cattle and 15 carabaos were used. In testing each lot of vaccine, a total of 94 cattle costing ₱5,551.15 were used.

A total of 2,072,750 c. c. of vaccine were manufactured during the year, equivalent to 460,611 doses at an average dose of 4.5

c. c. There was on hand, January 1, 1927, 810,700 c. c., making a total of 2,883,450 c. c. of which amount 2,240,450 c. c. was used in the campaign against rinderpest, leaving a balance on hand December 31, 1927, of 643,000 c. c. There were administered 377,473 vaccinations against 318,481 vaccinations during the year 1926.

Anti-rinderpest serum.—A total of 196,675 c. c. of anti-rinderpest serum valued at ₱3,146.80 was manufactured during the year, of which 177,800 c. c. valued at ₱2,844.80 were sold or used.

Immunity test of Pnom-Pehn cattle and carabaos.—Five shipments of cattle and carabaos totaling 864 animals received from Pnom-Pehn were injected with rinderpest virulent blood to test the effectiveness of immunization in Indo-China.

Animals immunized (simultaneous method).—Twenty-nine native cattle, 20 native carabaos and 8 Australian cattle were immunized by the simultaneous method as compared with 438 animals immunized by this method last year.

Anthrax.—Three specimens were submitted to the Laboratory. One from Dagupan, one from Batangas and one from Tarlac, proved positive for anthrax.

Vibrion septique infection.—One case was observed in a vaca that had undergone simultaneous immunization at the quarantine station at Iloilo.

Hemorrhagic septicemia.—One specimen positive for hemorrhagic septicemia was received from Antipolo.

Coccidiosis.—Two Ayrshire bulls imported by the Bureau of Agriculture for breeding purposes and sent to the Alabang Stock Farm for that purpose were definitely diagnosed as being affected with coccidiosis.

Epizoötic lymphangitis.—Laboratory examination of nodules obtained from a horse in Santo Tomas, Batangas, and from a rig pony owned by the Bureau of Agriculture both proved positive for this disease. The horse owned by the Bureau of Agriculture is now being experimentally treated with mercuric iodide given intravenously by Major R. A. Kelser, V. C., U. S. A. Encouraging results are being obtained.

Osteomalacia.—One case of this disease occurred in a Welsh pony used for stud purposes at the Alabang Stock Farm. This horse was so badly affected that it was necessary to destroy him.

Hog cholera and swine plague.—There were but two outbreaks of hog cholera. One severe outbreak of uncomplicated hog cholera occurred on the premises of a public institution in Rizal

Province. The other, which was found to be complicated with swine plague, was on a large farm within the city limits of Manila. In both instances a definite diagnosis was established and immunization of the well animals advised.

Tuberculosis.—Meat dealers at the Azcarraga Matadero having questioned the decision of the meat inspector who condemned hogs for tuberculosis, specimens were submitted to this laboratory for examination.

Edematous vulvitis.—One case of this disease was observed in a cow belonging to an owner in Manila. This disease has but newly been reported in the United States.

Rabies.—During the year 23 brain specimens were submitted for examination. Of this number, 7 were positive.

Fowl cholera.—Specimens of dead fowls submitted by three poultry raisers in the City of Manila and one from Malabon, Rizal, proved positive for fowl cholera on postmortem, cultures and transmission experiments.

Forage and forage crops.—As in former years, the principal green forage grasses grown in the laboratory fields were Guinea grass, Napier grass, Japanese cane, and corn.

Small animals.—The laboratory has continued to be successful in raising guinea pigs, which are used for routine vaccine and virus blood tests as well as for general laboratory diagnosis purposes.

Improvements in building and equipment—Advances in sterility of manufacture—Economies effected.—Marked improvements along these lines were made during the year. Concentration of vaccine processing operations in consecutive order in one building was effected by the construction of three appropriate rooms adjacent to the operating room. The giant steam sterilizer made according to special design late last year has proved satisfactory. Another piece of apparatus designed at the Pandacan Veterinary Research Laboratory is now being made at the Bureau of Commerce and Industry. It is expected to markedly increase the efficiency of these operations.

In order to safeguard the purity of virus and vaccine, purity (safety) tests were inaugurated this year on each lot to assure positive knowledge of freedom from disease-producing contaminating organisms.

Important economies were effected during the year.

Vaccine sub-station.—A new branch laboratory for diluting vaccine was opened at Vigan, Ilocos Sur.

Research.—The major project this year was the continuance of research on the improvement of rinderpest vaccine, which work was started last year by Major R. A. Kelser, V. C., U. S. A. and the Bureau of Agriculture working in collaboration. At this writing, laboratory experimentation is drawing to a close, the results of actual tests on cattle and carabaos indicating that a new method of preparation has improved the vaccine in three important ways: firstly, the time of preparation has been shortened from two to three months to seven to eight days; secondly, the maintenance of potency in storage has been increased from four to six weeks, to one year or more; thirdly, the immunization which has been obtained with one injection as compared with three to six injections with the old vaccine.

Animal disease control education.—The first public demonstration showing the method of manufacture and administration of rinderpest vaccine was held in the Philippine Carnival, Manila, February 12 to 27, 1927, a booth having been secured in connection with the Livestock Show. Methods of controlling disease were shown by means of booklets, charts, specimens, lantern-slides and lectures. Public interest prompted similar exhibits at Iloilo, Silay, and Ilagan carnivals during the year. Animal disease control education was also promoted by means of newspaper articles, lectures given in public schools, and radio lectures given by members of the division.

Iloilo Quarantine Station.—The laboratory shed has served as the rinderpest vaccine sub-station for the provinces in Panay Island and Occidental Negros Province. Only 1,134 carabaos and 70 cattle were received at this station from Pnom-Penh.

Sisiman Matadero.—Of the 7,966 Australian cattle slaughtered, 62 were condemned, and 7,904 passed for food.

ANIMAL HUSBANDRY SECTION

As usual the personnel gave pratical demonstration on the care of livestock and performed castration and caponization free of charge and instructed the public by lectures (radio and other) and by articles and letters.

The total income from the sale of livestock, eggs, etc., was ₱20,114.50; the estimated value of stock not sold, ₱6,010; the estimated increased value produced in the public breeding service, ₱56,215.

The Bureau assisted poultry raisers by acting as intermediary in the disposal of over 1,500 Cantonese and pure bred chickens. Less than 200 of other livestock were sold.

At the Carnival Livestock Fair on February 12–27, 1927, the Bureau exhibited pure bred and mestizo animals in competition with those of the College of Agriculture and private concerns and got most of the blue ribbons. Many animals were sold there at very good prices. Bids for ₱800 to ₱1,500 were offered for Sultan, a young mestizo pony, but he is reserved for public breeding work.

Alabang Stock Farm.—The area planted to rice and forage was again increased. An allotment of ₱2,971 was made for alterations and repairs of buildings, but many more need repair.

Cattle.—Great care was given the two Ayrshire bulls newly imported from Australia. Nineteen cows were bred to the old bull but only one to the young bull, the two Sussex bulls intended for use in a preliminary test for beef cattle improvement are at Alabang temporarily, being crossed with Indian cows. Later they will be transferred to La Carlota.

Horses.—Horse raising at Alabang is satisfactory. The Arabian stallion served 15 mares and there are 2 colts and 3 fillies that are the get of the bay stallion. Three privately owned mares have been served by this stallion and 7 have dropped their foals. The Welsh pony sent to the Mountain Province for public breeding purposes died soon after his return to the farm. He produced 6 female and 3 male foals at Alabang and was bred to 21 mares in the Mountain Province.

Sheep and goats.—There are 2 herds of goats, one headed by a Nubian buck and the other by a pure old Indian buck and the pure old Spanish buck. Mestizo Nubian bucks replaced the old bucks about the end of the year. The sheep flocks are headed by pure Shropshire rams.

Swine.—The Poland-China seem the hardiest and are crossed with native Batangas and Jalajala sows. (Results will be published later.) The Poland-China boar last imported promises to be the biggest boar the station has ever had. All his get are vigorous and well liked by the public.

Poultry.—The work on poultry has been the same as usual. During the dry season the incubator cellar was sprinkled and the incubators provided with moist sand. This increased the percentage of chicks hatched. In general the fowl project was satisfactory but the demand is too great and new fowls should be imported yearly particularly to prevent too much inbreeding.

The kamala for worms proved good for tapeworms and somewhat so for round worms, but it did not live up to the claim

that it will increase egg production. There were less eggs in fact.

La Carlota.—The weather was too rainy from May to October and the animals could not graze enough to satisfy their hunger. Intestinal parasites made conditions worse. Many died. Many chicks died also. Public interest was evidenced by the number of animals brought for breeding and by the number of visitors.

Repairs to buildings and sheds were made to the amount of ₱1,708.50.

Cebu Animal Breeding Station.—The work is producing most satisfactory results and attracting much public attention.

Batangas Animal Breeding Station.—The stallions and bulls kept in good condition throughout the year. Stallion No. 2242 is, however, rather old and will be replaced as soon as conditions warrant. The public breeding service is very greatly appreciated in Batangas as witness the time and money people spend to bring female animals for service. Total offspring reported: 108 fowls, 201 pigs and 148 calves.

Bayombong Cattle Breeding Station.—This station raises pure Indian cattle, and loans Indian bulls to cattle owners in Nueva Vizcaya. There are 9 old bulls, 7 of which run in private herds. The other 2 left with the Bureau herd served 45 cows, 26 of which calved.

A strong typhoon blew down the quarters and cattle sheds and ₱649 was spent for the repairs.

EXPERIMENTS

Cöoperative poultry-swine station.—Besides those of the Bureau of Agriculture, there are 11 maintained by the Bureau of Education and others by the provinces and other insular institutions. Three stations severed their connection with this Bureau by buying the animals loaned to them. The Santa Barbara poultry-swine station in Pangasinan is the most progressive. The province appropriated ₱3,000 for it and the nursery in 1927.

PUBLICATIONS DIVISION

WORK DURING THE YEAR

During 1927, there was an increase in the number of new publications issued and in the total of publications distributed. The publications printed were as follows: One annual report; 4 issues of the Philippine Agricultural Review; 1 bulletin; 23 new

circulars; 18 old ones; 5 reprints; 5 miscellaneous publications; 5 posters; 1 map; and 4 issues of the "Ang Magsasakang Pilipino." The number of publications distributed was 201,909 as against 167,713 in 1926 or an increase of 34,198.

Ang Magsasakang Pilipino.—The publication of the Philippine Farmer was resumed but in Tagalog only for the benefit of the Tagalog-speaking farmers. As soon as enough funds are made available it will also be published in as many dialects as possible.

Miscellaneous agricultural information.—All important information given out by the Bureau in correspondence was compiled and issued as Volume II.

Radio lectures.—Two series of radio lectures were broadcasted and the first series of 20 published.

Miscellaneous publications.—Five other publications on miscellaneous subjects were issued during the year.

Reprints.—Five reprints from the Philippine Agricultural Review were made.

Posters.—Five posters were prepared but only the one on sugar printed for distribution; the others were exhibited at the Manila and Iloilo carnivals.

Typhoon map.—A map of typhoons crossing the Philippines for the period 1903 to 1925 was prepared from the data of the Weather Bureau.

RECOMMENDATIONS

It is earnestly recommended that in the preparation of the appropriation for this Bureau for next year, a sufficient amount be included to provide for additional technical personnel to take charge of the increasing activities of this Bureau especially in the field. This Bureau is continually receiving urgent requests from provincial officials for the services of extension agents, veterinarians, and plant inspectors, but due to its inadequate appropriation it can not comply with most of these requests. This Bureau is also in need of six statistical inspectors to check and verify statistical data furnished by municipal officials.

Our sugar technologist having resigned to accept a better offer in one of the sugar centrals, it is asked that one of our men be sent abroad to specialize on sugar technology work in the United States, Cuba, Hawaii and Java. It is also recommended that another employee be sent to Brazil and other South American countries to specialize in the production of coffee and cacao.

As previously recommended two more experiment stations, one for upland rice and another for coconuts, should be established.

In the public works appropriation for next year it is requested that allotments be provided for the following buildings badly needed by this Bureau:

(*a*) One at the Alabang Stock Farm in which to carry on the experiments on feeding swine and poultry;

(*b*) One at the same station for a dairy house;

(*c*) One at the same station for office and laboratory;

(*d*) The necessary buildings for the new rice and coconut stations requested elsewhere;

(*e*) An insectary house and an adequate building for a plant pathology and soil laboratories at the Singalong Propagation Station;

(*f*) An insect-proof greenhouse on the Plant Quarantine lot for the investigation of foreign plant diseases and pests; and

(*g*) Six adequate fumigation buildings—one for each port of entry; namely, Manila, Cebu, Iloilo, Legaspi, Davao, and Zamboanga.

It is also requested that a special fund be provided in the Budget for next year for the participation of the Bureau of Agriculture in garden days, fairs and expositions held in the provinces, as this participation is one of the effective means by which this Bureau can show the many advantages of scientific and better methods of farming.

It is also recommended as in previous years that a suitable lot of about four hectares in area somewhere in Manila or some neighboring place be acquired on which to conduct field experiments on various plant pests and diseases and to plant quarantined materials coming from abroad.

It is hereby requested that more funds be asked for printing purposes so that the "Philippine Farmer" can be published in other dialects for the benefit of those farmers who read neither English, Spanish, or Tagalog.

And lastly, it is recommended that when the Philippine Legislature meets next year (1928) its attention be invited to the need for the following legislation:

(*a*) Acts appropriating sufficient funds for the eradication of coconut pests and diseases and sugar cane and rice pests and diseases.

(*b*) An Act authorizing this Bureau to use at least 20 per cent of the gross income of the experiment stations as a revolving fund for the maintenance of the said stations in order to raise funds to enable the Bureau to make more extensive experimentation.

(*c*) An Act amending the Administrative Code incorporating a penalty for municipal officials who fail to submit the quarterly crop and livestock

reports on time or who submit inaccurate or falsified reports. This Bureau has found great difficulties in the preparation of farm statistics so necessary to agriculture, commerce and industry, in view of the fact that municipal officials have the habit of submitting the reports required from them only after considerable delay and of the further fact that many of these reports contain inaccuracies due to carelessness.

(*d*) An Act amending the Rural Credit laws so as to grant the Director of Agriculture more extensive power than that now allowed him—to make his authority commensurate with his responsibility. At present the Director of Agriculture is a mere adviser and supervisor of the rural credit associations. He can not even put a stop to irregularities in the management of the associations, as he is restrained by law from taking any drastic action to close a bad association or even remove unworthy directors.

UPLAND RICE EXPERIMENTS AT THE LAMAO EXPERIMENT STATION, LAMAO, BATAAN 1921–1927

1921

General variety test.—Seventy-seven varieties were planted in plots 5 by 10 meters in size, June 25 to July 14, 1921 at the Lamao Experiment Station, Lamao, Bataan. The seeds were 5 to 7 in number in the hills, and the space between the hills in the row was 20 centimeters, while the rows were 50 centimeters apart.

A considerable number of the seedlings were attacked by a disease that caused a gradual wilting of the leaves and rotting of the roots. Other diseases observed were the smut, mildew and another fungus disease that caused spots on the leaves. But only a little of the smut was found. The mildew was present in a portion of the plots planted to the Bandera, Binabaye II, Binicol II, Kinalangkang, Pilit Morado, White Mangasa, Capayong, and Colapdos varieties. "Mayang pula" visited the fields, in spite of the scarecrows that were put up. Fortunately, however, very slight damage was done by these birds. Rice bugs were only rarely seen in the field and the damage done by them was of no consequence.

The following named varieties were found to be the most promising: Inaslom, Buaoa, Pol-lique, Quinirispinong puti, Binagontauo, Binoguinguin, Kinacao, San Fabian, Guinaboc, Aikoku, Guimat, Inantak, Tonguitan, Bayangbang, Kapotol, Roxas, Bulao, Nagsayang pula Kinanda, Sagoboy, Mangasa II, Binabaye II, Kinilay, Mayoro, Naglantik, Daliket or Sanglay, Lubang pula, Quinokong uwak, Caña Bombo, Lubang Blanco, Kinanda, Binicol II, Galong Sta. Maria, Ngapol, Pilit Morado, Binongang Loay, and Macatibos.

TABLE I.—*Variety test of upland rice at the Lamao Experiment Station for the year 1921*

Perm. No.	Variety name	Age at maturity	Computed yield per hectare, 100 per cent stand	
		Days	*Kilos*	*Cavans*
777	Sagoboy	122	1,300.00	29.55
1320	Guinamat	113	760.00	17.27
1110	Mangasa II	114	1,100.00	25.00

TABLE I.—*Variety test of upland rice at the Lamao Experiment Station for the fiscal year 1921*—Continued

Perm. No.	Variety name	Age at maturity	Computed yield per hectare, 100 per cent stand	
		Days	*Kilos*	*Cavans*
1324	Kinacao	125	1,100.00	25.00
1342	Ngapol	116	1,120.00	25.45
1329	Kinilay	123	1,020.00	23.18
	Malagoso	120	900.00	20.43
260	Caporcas I	111	920.00	20.91
1334	Pilit Morado	123	1,040.00	23.63
1318	Galong Famy	118	560.00	12.73
1314	Cuoab	119	680.00	15.46
1048	Inintiw	110	800.00	18.18
	Macan II	110	580.00	13.18
1244	Cainti	112	680.00	15.46
1485	White Mangasa	114	760.00	17.27
1319	Galong Santa Maria	132	1,000.00	22.73
1326	Kinanda	112	1,320.00	30.00
644	Nagsayang Pula	123	1,500.00	34.09
966	Daliket	111	1,060.00	24.09
520	Lubang pula	112	1,160.00	26.36
1332	Naglantik	117	1,160.00	26.36
1103	Lubang blanco	120	1,280.00	29.09
1139	San Fabian	116	1,180.00	26.82
282	Caririt	128	700.00	15.91
1302	Binagacay	128	560.00	12.73
1216	Kinandang pula	113	740.00	16.82
205	Colapdos	127	640.00	14.32
262	Kapotol	116	2,020.00	43.64
1311	Carabao	137	180.00	4.09
448	Inaslom	118	1,040.00	23.63
613	Mayoro	127	1,040.00	23.63
1181	Pol-lique	119	1,700.00	38.63
81	Binalintin	122	580.00	13.18
1321	Guinan	125	580.00	13.18
1284	Guinaboc	146	1,520.00	34.55
1312	Capayong	120	940.00	21.36
120	Bulagsac	110	760.00	17.27
937	Binicol II	123	1,260.00	28.63
	Bulao IV	109	1,368.00	31.09
1304	Binongang loay	131	1,360.00	30.93
1361	Binoguinguin	125	1,020.00	23.18
620	Minantica I	130	640.00	14.54
572	Malido	130	680.00	15.45
1339	Tonguitan	115	1,380.00	31.36
1489	Inantak	125	1,160.00	26.36
1299	Bayangbang	121	1,740.00	39.54
1279	Bandera	123	800.00	18.18
229	Calonod	124	540.00	12.27
1335	Quinirispinong Puti	110	1,020.00	23.18
1313	Carawin	111	2,020.00	23.18
	Caluis	125	560.00	12.72
980	Kinastila IV	116	920.00	20.91
1125	Pinili a biit	140	520.00	11.82
1309	Caña Bombo	124	1,600.00	36.36
338	Dali	131	880.00	20.00
1341	Buaoa	114	1,000.00	22.72
78	Binagontauo	115	1,000.00	22.72
1330	Layag	116	960.00	21.32
	Dap-pog	107	580.00	13.18
67	Binabaye II	118	1,040.00	23.67
1283	Menita	122	940.00	21.36
1346	Kinalangkang	123	740.00	14.54
1343	Quinokong Uwak	123	1,160.00	26.36
1340	Unoy dagoydoy	114	860.00	19.54
1317	Dinolores	125	780.00	17.72
1097	Initlog dalag	125	420.00	9.54
	Piniling Malatiit	125	580.00	13.18
1332	Guimat	115	1,220.00	27.72
1004	Roxas	138	1,240.00	28.18
956	Inantipolo II	126	680.00	15.75
1217	Kinandang puti	111	640.00	14.54
1333	Luyot	116	900.00	20.45
958	Macatibos I	126	1,040.00	23.67
1488	Casogsong	(a)	(a)	(a)
	Cabijud	126	640.00	14.51
1353	Aikoku	138	1,580.00	35.97
306	Catorsa	125	560.00	~~124.2~~ 12.72

[a] Failed to produce marketable grains.

1922

General variety test.—In the preceding year's cultures only 77 varieties were studied but this number was raised to 210 and included those received from La Carlota Experiment Station and those varieties collected locally.

About 10,250 square meters of land was used for this culture. It was fairly well prepared and divided into plots of 5 by 10 meters (50 sq. m.). The plantings were made from June 17 to June 29, 1922, inclusive, at a distance of 30 by 20 centimeters with 3 or 4 seeds to a hill. Germination took place from June 22 to July 5, 1922.

A month after, that is, when the seedlings were about 30 centimeters high thinning was done, only one vigorous plant being left to each hill. This culture was weeded twice by hand and with garden hoes.

Table II indicates the behavior of each variety tested during the year.

TABLE II.—*Variety test of upland rice at the Lamao Experiment Station for the year 1922*

Perm. No.	Variety name	Age at maturity	Actual yield	Computed yield per hectare	
		Days	*Kilos*	*Kilos*	*Cavans*
1320	Guinamat	124	1.16	232.00	5.32
937	Binicol II	126	1.24	248.00	5.61
613	Mayoro I	126	.93	186.00	4.26
1343	Quinokong uwak	130	.28	56.00	1.29
520	Lubang Pula	126	1.78	356.00	8.16
260	Caporcas I	119	.64	128.00	2.93
1339	Tonguitan	117	1.14	228.00	5.22
1313	Carawin	127	3.25	650.00	14.90
980	Kinastila IV	[a]	[a]	[a]	[a]
1330	Layag	117	.75	150.00	3.44
958	Macatibos I	130	2.02	404.00	9.26
1383	Menita	129	1.57	314.00	7.20
1332	Guimat	112	.65	130.00	2.98
1312	Capayong	138	[b]	[b]	[b]
448	Inaslom	129	[b]	[b]	[b]
1348	Gubas IV	108	[b]	[b]	[b]
338	Dali	[a]	[a]	[a]	[a]
1340	Unoy dagoydoy	116	1.16	232.00	5.32
1334	Pilit morado	118	2.70	540.00	12.38
1181	Pol-lique	125	[b]	[b]	[b]
67	Binabaye II	128	2.69	538.00	12.34
78	Binagontauo	128	[b]	[b]	[b]
1110	Mangasa II	127	[b]	[b]	[b]
1324	Kinacao	131	2.27	454.00	10.41
1342	Ngapol	127	.92	184.00	4.22
1326	Kinanda	132	.98	196.00	4.50
1004	Roxas	[a]	[a]	[a]	[a]
1332	Naglantik	128	2.92	584.00	13.39
644	Nagsayang Pula	135	3.64	728.00	16.69
1299	Bayangbang	133	2.23	446.00	10.22
1319	Galong Sta. Maria	132	[b]	[b]	[b]
1139	San Fabian	136	2.04	408.00	9.35
1335	Quinirispinong Puti	137	2.55	510.00	11.69
1489	Inantak	133	2.98	596.00	13.67
1361	Binoguinguin	123	3.24	648.00	14.86
1309	Caña Bombo	132	2.23	446.00	10.22
1353	Aikoku	135	2.79	558.00	12.79
1333	Luyot	120	.72	144.00	3.30
966	Daliket or Sanglay	[b]	[b]	[b]	[b]
1329	Kinilay	138	2.22	444.00	10.18

[a] Failed to produce crop. [b] Very few panicles produced.

TABLE II.—*Variety test of upland rice at the Lamao Experiment Station for the year 1922*—Continued

Perm. No.	Variety name	Age at maturity	Actual yield	Computed yield per hectare	
		Days	*Kilos*	*Kilos*	*Cavans*
1304	Binongang Loay	129	4.61	922.00	21.14
1284	Guinaboc	134	2.57	514.00	11.78
1103	Lubang Blanco	132	3.18	636.00	14.58
1279	Bandera	130	[b]	[b]	[b]
572	Malido	136	3.82	764.00	17.52
1314	Cuoab	126	1.19	238.00	5.45
262	Kapotol	139	5.00	1,000.00	22.93
1485	White Mangasa	129	2.51	502.00	11.51
1048	Inintiw	122	2.22	444.00	10.18
282	Caririt	138	2.28	456.00	10.45
120	Bulagsac	.....	.....	.....	.....
1341	Buaoa	126	1.49	298.00	6.83
620	Minantica I	[a]	[a]	[a]	[a]
1217	Kinandang puti	113	1.26	252.00	5.77
1216	Kinandang pula	113	1.28	256.00	.....
205	Colapdos	138	2.98	596.00	13.67
1317	Dinolores	134	.91	182.00	4.17
987	Magdalena	129	2.30	460.00	10.55
1213	Inagsaya	136	1.09	218.00	5.00
639	Nagdami	132	1.84	368.00	8.44
1331	Mita	[a]	[a]	[a]	[a]
1298	Ban-ar	131	1.35	270.00	6.19
1188	Sekitoii	[a]	[a]	[a]	[a]
1559	Cutsiam	121	.....	.....	.....
1307	Cabon	111	.....	.....	.....
1158	Cammang	124	.....	.....	.....
1382	Guinatas	107	.....	.....	.....
1287	Oag-oag	122	.....	.....	.....
1249	Nagrion	136	1.46	292.00	6.69
1166	Kinandang kumpol	137	.58	116.00	2.66
1230	Naglihim	126	1.97	394.00	9.03
362	Dinagat I	123	.....	.....	.....
1292	Early Prolific	[a]	[a]	[a]	[a]
619	Mantica Pilit	127	3.05	610.00	13.99
1252	Bangol	129	1.38	276.00	6.33
879	Tinomanan	132	.....	.....	.....
1189	Takenari	[a]	[a]	[a]	[a]
1560	Buluhan	100	.....	.....	.....
1565	Kinamantigue	137	1.89	378.00	8.67
1558	Daliket	98	.....	.....	.....
1161	Dinalaga V	124	.....	.....	.....
1315	Danilog	126	1.02	204.00	4.67
515	Lubang II	130	1.70	340.00	7.79
1350	Araw	[a]	[a]	[a]	[a]
1305	Cabayo	128	2.80	560.00	12.84
1178	Piatan	131	.....	.....	.....
970	Cayangcang	135	.....	.....	.....
1500	Macapno	134	1.51	302.00	6.92
47	Barangcal	131	1.71	342.00	7.84
1338	Tapacoy	134	2.25	450.00	10.32
1351	Oyoy	138	1.35	270.00	6.19
1290	Blue Rose I	[c]	[c]	[c]	[c]
791	Sanglay puti	125	.....	.....	.....
1348	Cadidi	138	1.12	224.00	5.13
1001	Apostol	132	2.28	456.00	10.45
1147	Cutsiam II	124	1.15	230.00	5.27
1150	Balasang	[c]	[c]	[c]	[c]
1286	Minacan	132	[b]	[b]	[b]
1288	Agsam	126	[b]	[b]	[b]
1336	Sinadyaya	[a]	[a]	[a]	[a]
1062	Bebe	126	[b]	[b]	[b]
1328	Malagayang Tapol	124	[b]	[b]	[b]
1262	Kinastila	124	.....	.....	.....
1248	Kathisod	[c]	[c]	[c]	[c]
999	Hinirang	129	3.21	642.00	14.72
1100	Lampadan or Allañgigan	120	4.16	832.00	19.08
1490	Sinaria	129	3.38	676.00	15.50
1246	Siamese Rice	[c]	[c]	[c]	[c]
951	Kalibod	130	1.64	328.00	7.52
1267	Carolina Gold II	[a]	[a]	[a]	[a]
126	Bulandi	137	2.40	480.00	11.00
1285	Kinampupoy	122	1.93	386.00	8.85
1250	Thul chalong	129	1.88	376.00	8.62

[a] Failed to produce crop. [b] Very few panicles produced. [c] Failed to germinate.

TABLE II.—*Variety test of upland rice at the Lamao Experiment Station for the year 1922*—Continued

Perm. No.	Variety name	Age at maturity	Actual yield	Computed yield per hectare	
		Days	*Kilos*	*Kilos*	*Cavans*
1325	Kinayabog	130	2.08	416.00	9.54
774	Sacsek	125	4.28	856.00	19.63
Check		127	2.57	514.00	11.78
1347	Caviteña a biit	126	1.52	304.00	6.97
1146	Casulig	130	1.17	234.00	5.39
1184	Ugnas	[a]	[a]	[a]	[a]
1148	Tuhao III or Caot	132	1.41	282.00	6.46
943	Bonguet	132	.82	164.00	3.76
991	Malagkit-kaawa	130	1.22	244.00	5.59
1247	Khao Bai Sri	[c]	[a]	[a]	[a]
1160	Cucuam	[a]	[a]	[a]	[a]
1133	Samban	127	.76	152.00	3.48
956	Inantipolo II	123	1.37	274.00	6.28
1386	Panay	128	1.17	234.00	5.36
1149	Bagsang	122	.96	192.00	4.40
1125	Pinili a biit	125	2.07	414.00	9.49
574	Maliro	124	2.74	548.00	12.56
1117	Minantica IV	129	[b]	[b]	[b]
1316	Dayome	133	2.35	470.00	10.77
1231	Nagoyon	127	3.24	648.00	14.86
1302	Binagacay	129	2.14	428.00	9.82
1179	Piniling	127	.....	.....	.....
65	Binabaye	124	.....	.....	.....
1089	Diquet a Pinasagad	[a]	[a]	[a]	[a]
254	Capichola	126	1.79	358.00	8.21
363	Dinagat II	116	.....	.....	.....
1073	Calibug	127	2.10	420.00	9.63
718	Pulupot I	125	.....	.....	.....
1050	Kinastila V	115	2.04	408.00	9.35
983	Buluhan	120	.....	.....	.....
1323	Inacopañga	123	1.40	280.00	6.42
990	Kaawa	122	2.63	526.00	12.06
1328	Check	124	2.94	588.00	13.47
530	Macan Piña	126	1.22	244.00	5.59
92	Binicol I	125	.85	170.00	3.89
945	Catalong	126	[b]	.....	.....
1289	Amariles	125	1.26	252.00	5.77
1337	Sarocot	124	.93	186.00	4.26
1301	Bihoralog Pula	136	.54	108.00	2.47
1226	Mangasa I	127	.48	96.00	2.20
1193	Kinastila VII	125	.43	86.00	1.97
998	Macarañag II	120	.96	192.00	4.40
562	Malagaya	122	[b]	.....	.....
1561	Lintang anod	123	.52	104.00	2.38
1300	Berilhon	124	2.38	476.00	10.91
Check		.....	[a]	.....	.....
1364	Binagontauo	123	3.04	608.00	13.94
979	Nagpunit	120	3.01	602.00	13.80
1387	Pinalengke	124	1.95	390.00	8.94
1234	Piniling Bebay	125	1.78	356.00	8.16
673	Pileng Baybay	127	1.13	226.00	5.18
1136	Sinaba III	124	1.56	312.00	7.15
1111	Mayoro II	.....	[a]	.....	.....
1101	Langauisan	121	1.81	362.00	8.30
1310	Caponguit	128	2.85	570.00	13.07
1138	Sinampaga	122	3.82	764.00	17.52
815	Sinacoban	121	[b]	.....	.....
1320	Check	118	2.24	448.00	10.27
971	Kinastaño II	125	3.32	664.00	15.22
969	Binucawe	133	.96	192.00	4.63
967	Binondoc II	129	1.15	230.00	5.27
724	Putyucanon	126	1.14	228.00	5.22
New	Guinulong	127	.77	154.00	3.53
New	Bulagsac	129	[b]	.....	.....
New	Dinularo	134	.....	.....	.....
306	Catorsa	124	1.16	232.00	5.32
229	Calonod	143	1.93	386.00	8.85
1482	Pinili	130	[b]	.....	.....
1329	Malagoso	127	[b]	.....	.....
1097	Initlog dalag	133	[b]	.....	.....
1308	Caluis	135	[b]	.....	.....
347	Dap-pog	133	[b]	.....	.....
1318	Galong Famy	.....	[a]	.....	.....

[a] Failed to produce crop. [b] Very few panicles produced. [c] Failed to germinate.

TABLE II.—*Variety test of upland rice at the Lamao Experiment Station for the year 1922*—Continued

Perm. No.	Variety name	Age at maturity	Actual yield	Computed yield per hectare	
		Days	*Kilos*	*Kilos*	*Cavans*
81	Binalintin	135	[b]		
12	Amayan	127	[b]		
777	Sagoboy	135	1.38	276.00	6.33
1244	Cainti	144	[b]		
1311	Carabao		[c]		
1188	Seketori		[c]		
1321	Guinan	115	3.34	668.00	15.32
New	Pinursigue	127	3.79	758.00	17.38
1573	Persian No. 1		[c]		
1574	Persian No. 2		[c]		
1575	California Var. No. 1600		[c]		
1294	Gopher	118	2.62	524.00	12.01
1295	Storm Proof	119	3.61	722.00	16.55
1264	Honduras	118	[b]		
1293	Edith	120	[b]		
1168	Vintuba	117	[b]		
New	Panagaraw Kabuad No. 1	[d]	[d]		
New	Panagaraw na Pula No. 2	[d]	[d]		
New	Panagaraw na Puti No. 3	[d]	[d]		
New	Dinulong	[d]	[d]		
New	Sinantamaria		1.43	286.00	6.55

[b] Very few panicles produced. [c] Failed to germinate. [d] Destroyed by atangia.

Though no diseases had invaded the field the plants suffered from drought during the month of September and for this reason many of the varieties failed to flower or produced only a few panicles.

From the table it will be noted that all the varieties gave poor results except the following: 1304 Binongang Loay, 262 Capotol, 1100 Lampadan or Allañgigan, 774 Sacsek, 1138 Sinampaga, 644 Nagsayang Pula, 572 Malido, Pinursigue, and 1295 Storm Proof, which yielded from 16 to 22 cavans or from 697 to 959 kilos per hectare each. Many of the varieties gave a very poor yield—not even enough seeds to keep the variety for the next trial planting. The low yields obtained in this test may be attributed partly to the poor preparation of the land and to the lack of cultivation.

1923

General variety test

1. Number of varieties 134
2. Area of land ..... 8,650 square meters
3. Area of individual plot ..... 50 square meters
4. Number of check plots 21
5. Previous crop ..... Rice and kibal
6. Amount of seeds planted ..... ½ liter for each plot
7. Date of planting ..... June 25, 26, 27 and 28 and July 5, 6, 1923
8. Method of planting ..... By the use of marker and then dropping the seeds by hand into the holes

General variety test—Continued.

9. Spacing	20 by 20 centimeters
10. Date of germination	July 5–9, 1923
11. Percentage of germination	85 to 98 per cent
12. Date of thinning and replanting	July 28–31 and August 1–23, 1923
13. Frequency of irrigation	Once, during the flowering season of the crop
14. Method of irrigation	Flooding
15. Frequency of cultivation	Once
16. Method of cultivation	Weeding by hand with a trowel covering the base of the plants with soil by the use of hoe
17. Date of harvesting	November 5–14, 1923
18. Actual expense per plot	₱0.47
19. Expenses per hectare	₱84
20. Results	No results could be obtained from this test because the plants were all carried away by a flood. However, the number of days of maturity could be determined.

TABLE III.—*Variety test of upland rice at the Lamao Experiment Station for the year 1923*

Age at Maturity	Variety name
Days	
100	Pilit Morado and Daliquet or Sanglay
102	Unoy Dagoydoy and Kinandang Pula
104	Kinandang Kumpol, Edith and Apostol
106	Luyot, Minacan, Malido, Bulandi, Nagsayang Pula, and Kinandang Puti
107	Aikoku, Buaoa and Putyucanon
108	Magdalena and Cayangcang
109	Binabaye II and Oyoy
110	Inacopanga, Dayome, Sinaba III, Bagsang and Cuoab
111	Kaawa
112	Kinastila V, Vintula, Gopher, Kinastila, Menita, Sanglay, Guimat, Bihoralog Pula and Casulig
113	Carawin, Macarañag II, Guinan, Nagdami, Magpunit, Binagontauo, Storm Proof, Calonod, Sinacoban, Dinagat II, Buluhan, Amariles, Inantak, Tapacoy, Tinomanan, Kinacao and Lubang Blanco
114	Kinastaño, Nagoyon, Kinastila IV, Mita, Binicol I, Guinulong and Bonguet
115	Thul Chalong, Dinalaga V, Catorsa and Danilog
116	Kalibod and Samban
117	White Mangasa, Caporcas I, Guinatas, Binoguingin, Catalong, Pulupot, and Binondoc II
118	Piniling, Piniling Baybay, Caviteña a Biit, Pinursigue, Sacsek, Hinirang, Panay, Capichola, Kinampupoy, Binabaye, Macan Piña, Cabayo, Sinampaga, Sarocot, Tonguitan, Naglantik, Inagsaya, Pol-lique and Calibug
119	Binagacay, Buluhan, Inantipolo II, Mangasa I, Quinukong Uwak and Mayoro
120	Bangol, Blue Rose I, Maliro, Langauisan and Tuhao or Caot
121	Lintang anod, Mangasa II, Malagkit Dinolores, Quinirispinong Puti, Cutsiam II, and Kinastila VII
122	Lampadan, Binucawe, Macatibos I, San Fabian and Kinanda
123	Pinalengke, Berilhon, Kinayabog, Inintiw, Caponguit, Pileng Baybay and Kinamantigue
124	Minantica, Naglihim , Inaslom, Binongang Loay, Nagrion, Capotol, Colapdos, Bayangbang, Caña Bombo, Malagaya and Barangcal
126	Pinili a Biit and Kinilay
127	Sinantamaria
128	Caririt and Piatan

Head-to-the-row test.

1. Number of varieties	5
2. Area of field	2,480.60 square meters
3. Area occupied by each variety	440 square meters
4. Area of check plot	44 square meters

Head-to-the-row test—Continued.

5. Number of check plots 6
6. Previous crops ..... Rice, cowpea, and soy bean
7. Amount planted ..... 100 heads in 100 rows to each variety
8. Date of planting ..... June 12, 13, and 14, 1923
9. Method of planting ..... By the use of a marker and then dropping the seeds by hand into the holes
10. Spacing ..... Twenty centimeters between rows and 20 centimeters between plants. Only one plant to the hill
11. Date of germination ..... June 16 to 18, 1923
12. Per cent of germination ..... Varies from 80 to 88 per cent
13. Date of thinning and replanting.. July 17 to 24, 1923
14. Replanting ..... The missing hills were replanted with plants taken from the same row
15. Frequency of irrigation ..... None
16. Frequency of cultivation..... Once
17. Method of cultivation ..... Covering the base of plants with soil with a garden hoe and weeding
18. Date of harvesting ..... November 28 and 29, 1923
19. Actual expenses ..... ₱56.31
20. Expenses per hectare ..... ₱251.21
21. Results ..... Out of the five varieties only one was left after the flood. The performance of this variety is shown in Table IV.

The results show that the computed yield per hectare varied from 225 to 1,850 kilos.

TABLE IV.—*Performance of Kinastila rice in head-to-the-row test at the Lamao Experiment Station for the year 1923*

Row number	Average number of stalks per stool	Average number of heads per stool	Average number of white heads	Average length of heads	Average number of grain per head	Yield	
						Actual	Per hectare
				Cm.		*Kilos*	*Kilos*
1	1	1	0	17.9	56	.012	600
2	1	1	0	19.8	135	.019	950
3	2.2	2.2	0	18.7	102	.020	1,000
4	1.6	1.6	0	16.5	112	.017	850
5	1.8	1.8	0	15.8	98	.016	800
6	1.4	1.4	0	17.3	112	.0155	775
7	1.4	1.4	0	19.3	109	.015	750
8	1.2	1.2	0	19.6	115	.014	700
9	2	2	0	18.1	91	.018	900
10	1	1	0	18.7	118	.012	600
11	1.4	1.4	0	17.9	108	.0145	725
12	1.6	1.6	0	16.1	100	.016	800
13	1.4	1.4	0	17.3	115	.017	850
14	1.2	1.2	0	19.7	130	.013	650
15	1.6	1.6	0	18.5	110	.0175	875
16	1.2	1.2	0	17.0	93	.0125	625
17	1	1	0	16.9	101	.010	500
18	2.2	2.2	0	15.3	79	.018	900
19	1.8	1.8	0	15.6	83	.015	750

TABLE IV.— *Performance of Kinastila rice in head-to-the-row test at the Lamao Experiment Station for the year 1923*—Continued

Row number	Average number of stalks per stool	Average number of heads per stool	Average number of white heads	Average length of heads	Average number of grain per head	Yield	
						Actual	Per hectare
				Cm.		*Kilos*	*Kilos*
20	1.6	1.6	0	17.8	83	.015	750
21	1.6	1.6	0	17.1	86	.019	950
22	1.6	1.6	0	16.4	84	.0165	825
23	1.8	1.8	0	15.4	70	.014	700
24	1	1	0	17.0	97	.009	450
25	1	1	0	15.5	92	.008	400
26	1.4	1.4	0	18.7	108	.016	800
27	1.2	1.2	0	16.5	97	.0105	525
28	1.8	1.8	0	15.5	79	.0165	825
29	1.6	1.6	0	17.2	95	.013	650
30	1.4	1.4	0	17.5	113	.017	850
31	2	2	0	15.65	84	.017	850
32	2	2	0	13.94	78	.013	650
33	1.8	1.8	0	15.7	72	.0125	625
34	1.6	1.6	0	17.4	93	.013	650
35	1.6	1.6	0	15.3	94	.0155	775
36	1.6	1.6	0	16.1	93	.016	800
37	2.2	2.2	0	17.5	101	.0225	1,125
38	1.6	1.6	0	17.0	106	.020	1,000
39	1.8	1.8	0	17.2	91	.015	750
40	1.6	1.6	0	17.3	87	.015	750
41	1.4	1.4	0	18.1	117	.016	800
42	1.8	1.8	0	17.6	87	.015	750
43	2	2	0	17.74	90	.0175	875
44	2	2	0	16.24	77	.0165	825
45	1	1	0	19.7	169	.018	900
46	2	2	0	18.38	88	.018	900
47	2.4	2.4	0	16.7	87	.0215	1,075
48	1.2	1.2	0	18.9	125	.012	600
49	1.2	1.2	0	17.1	112	.014	700
50	2.4	2.4	0	16.7	99	.023	1,150
51	1.6	1.6	0	17.1	96	.0175	875
52	2	2	0	17.17	103	.0205	1,025
53	1.6	1.6	0	18.3	120	.021	1,050
54	1	1	0	20.0	120	.013	650
55	1.2	1.2	0	18.2	122	.016	800
56	2.4	2.4	0	16.2	105	.027	1,350
57	1	1	0	17.5	115	.014	700
58	1.4	1.4	0	17.9	85	.011	550
59	1.2	1.2	0	20.9	149	.0165	825
60	1.4	1.4	0	16.4	100	.0105	525
61	1.2	1.2	0	17.9	121	.0135	625
62	1.2	1.2	0	19.2	147	.015	750
63	1.6	1.6	0	17.4	112	.0165	825
64	2	2	0	21.63	172	.037	1,850
65	2	2	0	18.22	103	.022	1,100
66	1.6	1.6	0	22.6	213	.032	1,600
67	1.2	1.2	0	21.1	170	.0175	875
68	1.8	1.8	0	18.2	134	.024	1,200
69	1.2	1.2	0	15.8	108	.012	600
70	1.4	1.4	0	20.2	159	.023	1,150
71	1.2	1.2	0	19.5	150	.0185	925
72	1.2	1.2	0	18.6	110	.0125	625
73	1.4	1.4	0	17.4	108	.0143	715
74	2	2	0	15.87	88	.0165	825
75	1.4	1.4	0	18.3	126	.0165	825
76	1	1	0	19.3	145	.0125	625
77	1	1	0	17.8	125	.012	600
78	1.6	1.6	0	16.7	114	.019	950
79	1	1	0	16.1	110	.0105	525
80	1	1	0	15.6	85	.0045	225
81	1	1	0	16.0	90	.0075	375
82	1.4	1.4	0	16.0	75	.011	550
83	1.4	1.4	0	16.4	95	.0125	625
84	1	1	0	20.1	122	.0105	525
85	2	2	0	15.91	76	.016	800
86	2	2	0	16.64	90	.017	850
87	1.2	1.2	0	16.6	91	.010	500
88	2	2	0	15.43	64	.010	500
89	1.6	1.6	0	16.9	96	.0155	775
90	1.8	1.8	0	18.9	113	.0175	875
91	1.2	1.2	0	17.6	128	.014	700
92	1.4	1.4	0	16.3	131	.016	800

TABLE IV.— *Performance of Kinastila rice in head-to-the-row test at the Lamao Experiment Station for the year 1923*—Continued

Row number	Average number of stalks per stool	Average number of heads per stool	Average number of white heads	Average length of heads	Average number of grain per head	Yield	
						Actual	Per hectare
				Cm.		*Kilos*	*Kilos*
93	1.8	1.8	0	16.8	100	.017	850
94	1	1	0	19.6	155	.018	900
95	1	1	0	20.5	130	.0125	625
96	1.4	1.4	0	16.2	78	.0075	375
97	1	1	0	15.3	78	.008	400
98	1	1	0	21.6	172	.017	850
99	1	1	0	17	104	.0105	525
100	1	1	0	16.5	95	.007	350

1924

General variety test.—The object of the experiment was to determine the best yielding variety of upland rice adapted to local conditions.

1. Number of varieties tested..... 60
2. Area of field used..... 6,480 square meters
3. Area occupied by each variety.... 95 square meters (approximately)
4. Number of check plots..... 8
5. Previous crops ..... Newly opened field
6. Date of planting..... June 20–21, 1924
7. Methods of planting..... By the use of a marker and then dropping the seeds by hand into the holes
8. Spacing ..... 20 by 20 centimeters
9. Date of germination..... June 23–24, 1924
10. Frequency of cultivation..... Only once
11. Method of cultivation..... Only weeding
12. Date of harvesting..... October 27 to November 14, 1924
13. Actual expenses per variety..... ₱0.76
14. Computed expenses per hectare.. ₱84.44
15. See Table V for the results of this test.

TABLE V.—*Variety test of upland rice at the Lamao Experiment Station for the year 1924*

Permanent number	Variety name	Percentage of stand	Age at maturity	Actual yield	Corrected yield at 100 per cent stand	Computed yield per hectare	
			Days	*Kilos*		*Kilos*	*Cavans*
	Check I (Inantipolo).....	94	128	14.30	15.21	.....	.....
1335	Quinirispinong Puti.....	95	133	8.96	9.43	841.11	19.29
1324	Kinacao.....	96	133	9.30	9.68	906.67	20.80
613	Mayoro I.....	97	133	8.40	8.66	831.11	19.06
644	Nagsayang Pula.....	92	128	11.82	12.85	1,334.44	30.61
1331	Mita.....	98	128	6.86	7.00	722.22	16.56
1226	Mangasa I.....	91	132	.90	.99	92.22	2.11
	Guininto.....	96	128	6.80	7.08	806.66	18.50
	Sanglay.....	88	139	2.16	2.45	330.00	7.57
362	Dinagat I.....	94	139	3.02	3.21	452.22	10.37
	Agri-Luya.....	89	129	7.82	8.78	1,108.89	25.43
1317	Dinolores.....	92	129	6.54	7.11	961.11	22.04
	Macan-Aga.....	96	(a)	.....	.....	.....	.....
	Check II (Inantipolo).....	96	128	10.34	10.77	.....	.....

[a] Immatured.

TABLE V.—*Variety test of upland rice at the Lamao Experiment Station for the year 1924*—Continued

Permanent number	Variety name	Percentage of stand	Age at maturity	Actual yield	Corrected yield at 100 per cent stand	Computed yield per hectare	
			Days	*Kilos*		*Kilos*	*Cavans*
673	Pileng Baybay	94	131	4.32	4.60	677.78	15.55
	Pinursigue	5	134	.03	.60	196.67	4.51
	Kinamalig	92	129	7.38	8.02	984.44	22.58
	Binohañgin	84	141	1.48	1.78	287.78	6.60
966	Daliket	92	125	.63	.68	95.56	2.19
1336	Sinadyaya	97	128	.58	.60	50.00	1.15
	Macan Kumpol	90	[a]				
998	Macarañag II	85	129	6.66	7.83	780.00	17.94
	Buric ni Martin	91	[a]				
	Vinirgin	96	129	6.52	6.80	592.22	13.58
	Check III (Inantipolo)	92	128	13.28	14.43		
	Check IV (Inantipolo)	94	128	10.48	11.14		
	Dinalaga	98	128	10.04	10.24	1,145.56	26.27
	Dinulis	96	133	14.78	15.32	1,708.89	39.19
937	Binicol II	95	128	13.68	14.40	1,605.56	36.84
1323	Inacopanga	92	128	9.28	10.08	1,124.44	25.79
	Inusin	95	128	11.04	11.62	1,294.44	29.69
1048	Inintiw	94	133	2.30	2.44	273.33	6.27
1050	Kinastila V	90	135	13.20	14.66	1,630.00	37.36
	Delitus	80	129	3.52	4.40	488.89	11.21
	Pauni	97	136	9.72	10.02	1,112.22	25.51
	Macaneng	86	[a]				
	Macan Pulo	92	140	2.60	2.82	310.00	7.11
620	Minantica I	93	135	3.64	3.91	430.00	9.86
	Check V (Inantipolo)	96	128	10.85	11.30		
	Inabaca	92	138	1.70	1.84	335.56	7.69
1110	Mangasa II	96	129	6.12	6.37	805.56	18.47
120	Binulagsak or Bulagsac	94	129	8.06	8.57	1,016.67	23.32
	Buric	88	129	5.58	6.34	757.78	17.38
	Minantica II	92	129	5.94	6.45	714.44	16.63
	Mangasa III	94	140	6.90	7.34	780.00	17.89
	Mimis	92	[a]				
	Kinawayan	90	143	2.42	2.68	162.22	3.72
	Check VI (Inantipolo)	94	129	13.48	14.25		
	Check VII (Inantipolo)	90	129	14.10	15.66		
1326	Kinanda	90	131	3.62	4.02	88.89	2.04
	Tapuy	88	136	2.60	2.95	10.00	0.23
	Nagkayat	82	130	2.92	3.56	117.78	2.70
956	Inantipolo II	84	129	10.20	12.14	1,151.11	26.49
990	Kaawa	92	130	3.55	3.85	270.00	6.10
	Inangel	96	130	4.05	4.21	350.00	8.03
	Buliro	90	130	1.25	1.38	75.56	1.73
1138	Sinampaga	86	130	1.65	1.92	175.56	4.03
	Quinate	88	130	1.95	2.21	247.78	5.68
	Dumali	84	116	1.35	1.60	220.00	5.04
	Malagkit Macapilay Pusa	92	136	0.87	0.94	186.67	4.28
	Buluhan	94	140	1.17	1.24	260.00	5.96
1364	Binagontauo	84	130	4.96	5.90	817.78	18.75
	Pirurutong	92	130	4.16	4.52	704.44	16.15
	Tintanos	97	130	5.20	5.36	837.78	19.21
1216	Kinandang Pula	96	137	2.48	2.58	568.89	13.05
	Tangi Sinampay Bacod	90	138	1.38	1.53	492.22	11.29
	Malagkit	87	142	1.10	1.26	502.22	11.52
	Check VIII (Inantipolo)	96	129	8.20	8.43		

[a] Immatured.

Excellent crops would have been obtained from this culture if they had not been injured by typhoons and attacks by "atangia," which made chaff of the heads. Those varieties that headed earlier and later as indicated in the table of production suffered the most. The grains of the early maturing varieties were eaten by "mayang pula." Five varieties, namely, the Macan-Aga, Buric ni Martín, Macan Kumpol, Macaneng and Mimis seemed to be lowland palay. Because of their late maturing characteristics, it was decided to omit them in the following

year's culture. This was the first test of the sixty-two varieties represented in the collections of upland rice at the Lamao Experiment Station.

From the results obtained as shown in Table VI the varieties which came out the best in the test were the Dinulis, Kinastila V, Binicol II, Nagsayang Pula, Inusin, Inantipolo II, Dinalaga, Inacopañga, Pauni, Agri-Luya, Binulagsak, Kinamalig, Dinolores and Kinacao in the order of their enumeration. The yield was from 20.8 to 39.2 cavans or 906.88 to 1,709.12 kilos per hectare.

Head-to-the-row test.—The object was to isolate the most productive strains responsible for the high yielding capacity of the crop and at the same time to establish pure line strains of the variety tested.

1. Number of varieties under test.... One (Kinastila)
2. Area of field used..... 424 square meters
3. Area occupied by each head..... 4 square meters
4. Number of check plots..... 6
5. Previous crops ..... Newly opened field
6. Date of planting..... June 27, 1924
7. Method of planting..... By using string in lining and markers made for the purpose. The marker was used to make the holes and 3 to 5 seeds were dropped into each hole.
8. Spacing ..... 20 by 20 centimeters
9. Date of germination..... June 30, 1924
10. Frequency of cultivation..... Only once
11. Method of cultivation..... Thinning and weeding
12. Date of harvesting ..... November 15, 1924
13. Actual expenses per plot..... ₱0.14
14. See Table VI for results.

TABLE VI.—*Head-to-the-row test of Kinastila rice at the Lamao Experiment Station for the year 1924*

Row number	Percentage of stand	Average number of culms per stool	Actual yield	Corrected yield at 100 per cent stand	Computed yield per hectare	
			Kilos		*Kilos*	*Cavans*
Check I	92	3	.240	.261		
1	68	4	.390	.574	1,562.5	33.54
2	24	4	.189	.788	2,085.0	47.82
3	53	4	.402	.759	2,000.0	45.87
4	50	3	.278	.556	1,480.0	33.94
5	50	3	.380	.840	2,177.5	49.94
6	60	3	.434	.723	1,872.5	42.95
7	95	3	.608	.640	1,652.5	37.90
8	86	3	.454	.528	1,360.0	31.92
9	91	3	.602	.662	1,682.5	38.59
10	38	4	.223	.587	1,482.5	34.00

TABLE VI.—*Head-to-the-row test of Kinastila rice at the Lamao Experiment Station for the year 1924*—Continued

Row number	Percentage of stand	Average number of culms per stool	Actual yield	Corrected yield at 100 per cent stand	Computed yield per hectare	
			Kilos		*Kilos*	*Cavans*
11	22	4	.195	.886	2,217.5	50.86
12	66	4	.469	.711	1,767.5	40.54
13	72	3	.410	.569	1,400.0	32.11
14	88	3	.433	.494	1,200.0	27.52
15	87	3	.477	.548	1,322.5	30.33
16	91	3	.487	.535	1,252.5	28.72
17	75	3	.355	.473	1,110.0	24.46
18	73	2	.229	.314	700.0	16.06
19	67	3	.262	.391	880.0	20.18
20	64	4	.335	.523	1,197.5	27.47
Check II	82	2	.306	.373		
21	63	3	.378	.600	1,587.5	36.41
22	79	4	.465	.590	1,555.0	35.67
23	82	3	.397	.484	1,257.5	28.84
24	69	3	.168	.244	675.0	15.48
25	26	4	.203	.781	2,010.0	46.10
26	52	2	.275	.529	1,372.5	31.48
27	50	3	.381	.762	1,947.5	44.67
28	85	3	.236	.278	730.0	16.74
29	63	3	.314	.499	780.0	17.89
30	77	3	.294	.382	975.0	22.36
31	73	2	.203	.278	707.5	16.23
32	64	2	.365	.570	1,430.0	32.79
33	84	3	.440	.524	1,307.5	29.98
34	90	2	.318	.353	872.5	20.01
35	77	3	.416	.540	1,332.5	30.56
36	70	2	.259	.370	900.0	20.64
37	78	3	.395	.506	1,232.5	28.26
38	71	3	.305	.430	1,035.0	23.74
39	69	3	.322	.467	1,120.0	25.68
40	78	3	.329	.422	1,000.0	22.93
Check III	86	3	.386	.449		
41	47	3	.245	.521	1,140.0	26.15
42	63	3	.427	.678	1,550.0	35.56
43	82	2	.352	.429	945.0	21.67
44	77	3	.395	.513	1,172.5	26.88
45	70	2	.262	.374	842.5	19.31
46	82	3	.424	.517	1,217.5	27.92
47	79	2	.325	.411	970.0	22.25
48	86	2	.284	.330	785.0	18.69
49	89	2	.531	.597	1,470.0	33.71
50	67	2	.191	.285	707.5	16.23
51	78	2	.301	.386	977.5	22.42
52	77	2	.255	.292	760.0	17.43
53	67	2	.303	.452	1,175.0	26.95
54	77	2	.332	.431	1,142.5	26.20
55	71	3	.323	.455	1,220.0	28.00
56	81	2	.265	.327	917.5	21.04
57	81	2	.304	.375	1,055.0	24.20
58	92	2	.435	.473	1,317.5	30.22
59	46	3	.251	.546	1,517.5	34.79
60	39	2	.186	.477	1,362.5	31.25
Check IV	74	2	.222	.300		
61	69	2	.246	.357	842.5	19.32
62	55	3	.159	.289	677.5	15.54
63	70	3	.244	.349	832.5	19.09
64	91	2	.391	.430	1,040.0	23.62
65	94	2	.374	.398	965.0	22.13
66	95	2	.253	.266	640.0	26.17
67	69	2	.211	.306	745.0	17.09
68	89	2	.195	.220	535.0	12.27
69	79	2	.256	.324	800.0	18.35
70	70	2	.294	.420	1,055.0	24.20
71	84	3	.294	.350	885.0	20.30
72	78	3	.243	.312	795.0	18.23
73	77	2	.239	.310	795.0	18.23
74	82	3	.233	.284	735.0	16.86
75	80	2	.254	.317	822.5	18.85
76	62	2	.203	.327	852.5	19.54
77	52	3	.226	.435	1,122.5	25.73
78	50	3	.240	.480	1,245.0	28.55
79	58	3	.183	.316	840.0	19.27
80	72	2	.185	.257	697.5	16.00

TABLE VI.—*Head-to-the-row test of Kinastila rice at the Lamao Experiment Station for the year 1924*—Continued

Row number	Percentage of stand	Average number of culms per stool	Actual yield	Corrected yield at 100 per cent stand	Computed yield per hectare	
			Kilos		*Kilos*	*Cavans*
Check V	84	2	.214	.255	.....	.....
81	72	2	.173	.240	822.5	18.85
82	77	2	.249	.323	1,012.5	23.21
83	64	2	.248	.388	1,152.5	26.43
84	73	3	.238	.326	975.0	22.36
85	77	2	.273	.355	1,025.0	23.51
86	61	2	.272	.446	1,480.0	33.94
87	63	2	.257	.408	1,112.5	25.51
88	65	3	.251	.386	1,035.0	23.74
89	67	2	.203	.303	805.0	18.46
90	60	2	.224	.373	957.5	23.10
91	71	3	.256	.361	905.0	20.75
92	49	3	.154	.315	767.5	17.60
93	48	3	.180	.375	895.0	20.53
94	74	2	.253	.342	790.0	18.12
95	63	3	.218	.346	777.5	17.82
96	81	3	.449	.554	1,225.0	28.10
97	76	2	.361	.475	1,055.0	24.19
98	62	3	.419	.676	1,535.0	35.21
99	78	2	.324	.415	860.0	19.72
100	52	2	.454	.873	1,982.5	45.46
Check VI	87	2	.396	.455	.....	.....

NOTE.—1 cavan=43.6 kilos. Average yield of all checks=0.349 kilo or 877.5 kilos to the hectare or 20.01 cavans.

Plants from selected seeds gave as high as 50.86 cavans or 2,217.50 kilos per hectare, as was the case with plant No. 11, whereas the average yield of the check variety where no selection was done was only 20.01 cavans or 872.43 kilos. Higher yields were also correlated with those plants having more culms per stool. As to the average number of culms per stool, the nonselected had in most cases less culms than the selected plants.

Seeding per hill.—The object was to determine the proper number of seeds to be planted in each hill that a high yield might be obtained.

1. Number of varieties tested..... One (Inantipolo)
2. Area of field occupied..... 236 square meters
3. Area for each test..... 20 square meters
4. Previous crops ..... Newly opened field
5. Date of transplanting..... August 12, 15 and 16, 1924, but the seedlings used were planted June 22, 1924
6. Method of transplanting..... The seedlings used in this test were taken from the propagation plot of Inantipolo. The top parts of the plants were cut off before transplanting. The holes were made with a marker and a trowel.

7. Spacing ..... 20 by 20 centimeters.
8. Date of initial growth..... August 19–21, 1924
9. Frequency of cultivation..... Only once
10. Method of cultivation..... Only weeding
11. Date of harvesting..... November 14, 1924
12. See Table VII for results.

TABLE VII.—*Seeding experiment at the Lamao Experiment Station for the year 1924*

Number of seed planted per hill	Seeding			Percentage of stand	Average number of culms per stool	Actual yield of grains	Corrected yield at 100 per cent stand	Computed yield per hectare
	Actual	Per hectare	Cost per hectare					
	Kilos	*Kilos*	*Pesos*			*Kilos*		*Kilos*
1	0.0125	6.25	0.57	94	4.0	0.82	0.87	435
2	0.0250	12.50	1.14	92	3.3	1.08	1.15	575
3	0.0375	18.75	1.71	96	3.7	1.20	1.25	625
4	0.0500	25.00	2.28	95	4.4	0.98	1.03	515
5	0.0625	31.25	2.85	93	5.9	1.24	1.33	665
6	0.0750	37.50	3.42	90	6.2	1.16	1.29	645
7	0.0875	43.75	3.99	97	7.2	0.96	0.99	495
8	0.1000	50.00	4.56	96	8.0	0.86	0.90	450
9	0.1125	56.25	5.13	93	9.0	0.78	0.82	410
10	0.1250	62.50	5.70	97	10.0	0.49	0.51	255

NOTE.—Cost per cavan of seed, ₱4.

Seeds should have been used in the test rather than seedlings in order to find out the real behavior of upland rice when few or many seeds were planted in each hill, but because of the lateness of the season seedlings from the propagation plot of Inantipolo palay had to be transplanted to carry out the test. Though seedlings were used the results obtained give an idea as to how many seeds should be dropped to the hill in planting upland rice. Planting a few seeds promoted the development of more culms per stool, whereas with many seeds there was no increase at all. Planting one and two seeds to the hill gave the highest average of culms per stool, but in grain production 5, 3, and 6 seeds per hill yielded the best. Judging from the above figures not more than six seeds to the hill of upland rice should be planted. Any more will only be a waste of seeds and cause a lower yield. The culture was attacked by "atangia," the heads became chaffy and the yield was consequently low.

Depth of planting.—Mayoro rice was used in the test. The results as tabulated below indicate that rice seeds should not be covered with soil to more than three centimeters deep. One centimeter is found to be the best depth. Besides, if planted 7 or 8 centimeters deep germination took place 10 to 11 days late.

TABLE VIII.—*Depth of planting experiment at the Lamao Experiment Station for the year 1924*

Depth (cm.)	Number of seeds planted	Date of—		Number of seeds germinated	Per cent of germination
		Planting	Germination		
1	6	3-14-24	3-19-24	6	100
2	6	3-14-24	3-19-24	4	66.67
3	6	3-14-24	3-20-24	5	83.33
4	6	3-14-24	3-21-24	2	33.33
5	6	3-14-24	3-21-24	2	33.33
6	6	3-14-24	3-21-24	1	16.67
7	6	3-14-24	3-31-24	2	33.33
8	6	3-14-24	4- 1-24	1	16.67
9	6	3-14-24	(a)	(a)	(a)
10	6	3-14-24	(a)	(a)	(a)
11	6	3-14-24	(a)	(a)	(a)

(a) Unable to reach the surface of the ground.

Seasonal planting.—Seeds of the Mayoro palay were used in this test. Planting was done monthly. The plantings from January to April gave no harvest. Crops were harvested only from the May planting. No planting was done in June because of the impossibility of preparing the too wet ground during that month. Seeds planted during the months of August to December failed to germinate, and there were no fresh seeds to be tested.

Longevity test.—Mayoro seed palay was preserved under two conditions; namely, in cloth bags and air-tight containers. Initial germination tests were made every month by planting 50 seeds in each test plot until the seeds had lost their entire viability. Table IX below gives the results of this experiment.

TABLE IX.—*Viability test of Mayoro Rice at the Lamao Experiment Station for the year 1924*

Date of—		Number of seeds tested	Control		Cloth bag		Air-tight container	
Planting	Germination		Number of seeds germinated	Percentage germination	Number of seeds germinated	Percentage germination	Number of seeds germinated	Percentage germination
2- 2-24	2-26-24	50	50	100	48	96	50	100
3-21-24	3-26-24	50	36	72	45	90	35	70
4-25-24	4-30-24	50	21	42	15	30	20	40
5-25-24	5-30-24	50	20	40	12	24	21	42
6-25-24	6-30-24	50	14	28	14	28	16	32
7-25-24	7-30-24	50	9	18	0	0	10	20
8- 8-24	8-14-24	50	1	2	26	52	7	14
9- 2-24	9- 8-24	50	1	2	22	44	7	14
10-15-24	10-22-24	50	(a)	0	20	40	10	20
11-13-24	.....	50	(a)	0	(a)	0	(a)	0
12- 6-24	.....	50	(a)	0	(a)	0	(a)	0

(a) None.

The viability of good rice seed may be retained by keeping it either in cloth bags or sacks or in air-tight containers for at

least nine months, while its germinative power decreases as it becomes old.

1925

General variety test.—Of the 66 varieties tried the Kinastila, Mayoro, Dinulis, Inantipolo, Binicol, Minantica II, Tapacoy, Tapuy, Buric and Macarañag gave the highest yields, from 14.25 to 24.10 cavans or from 621.3 to 1,050.76 kilos per hectare, while the other varieties yielded only from none to 14.14 cavans or 616.5 kilos. Eighty-one pesos and sixty-seven centavos (₱81.67) was the computed cost per hectare. A special variety test of Kinastila, Inantipolo, Dinulis and Binicol was also conducted during the year. The Kinastila and Inantipolo gave yields of 471.35 and 355.21 kilograms per hectare, respectively—the highest. The computed expenditure was ₱65.43 per hectare. Poor yields were obtained from these tests because of pests and diseases.

In the head-to-the-row test of Kinastila the highest yields were from 1,365 to 1,952 kilograms per hectare which is equivalent to 31.37 and 44.77 cavans. High yields were found to be correlated with the highest average of culms per stool and grains per head, and also with the length of the panicles.

The seeding experiment indicated that planting too many seeds to the hill gave no appreciable increase in the production of upland palay. Three to four seeds in each hill gave the highest yield. An increase of about 150 per cent was recorded in this experiment.

Kinastila seeds were planted at depths of 1 to 11 centimeters in seed flats. Seeds planted at from 1 to 5 centimeters deep gave from 80 to 100 per cent germination while seeds planted at from 6 to 11 centimeters deep could hardly reach the surface of the ground and gave only from 35 to 75 per cent germination.

The results obtained from the seasonal planting test indicated that the best time to plant upland rice was from May to August in the locality of Lamao. Plantings made after or before these months did not produce any yields unless irrigated.

Seed palay stored in cloth bags, paper bags, bottles and in bottles mixed with either ashes or soil were still viable at the end of eleven months. The two first named kinds of containers however, gave the highest percentage of germination—40 and 64 per cent.

1926

General variety test.—In spite of the attacks of worms during the early stages of the plants, good results were obtained from

the test, which embraced 63 varieties. Worms ate the plants in many cases down close to the ground thus causing low stands. The culture was rather weedy, for the low stands of the plants gave the weeds room to multiply. Efforts to combat the attacks of worms were of no avail because they were too numerous. Of the 63 varietes tested, the Mayoro, Sinampiro, Kinastila, Panay, Inantipolo, Binicol, Linuguan, Kinamalig, Sinampay Bakod, Pileng Baybay, Kinacao, Puti and Kinastaño gave the highest yields, which varied from 33.12 to 40.59 cavans or 1,444.03 to 1,769.72 kilos to the hectare. The other varieties yielded only from 4.11 to 29.08 cavans or from 179.20 to 1,267.88 kilos. The low yields of other varieties were due to their early maturing and the attacks of "atangia" and "maya." The computed cost of production was ₱84 per hectare.

A special variety test of the best varieties resulting from the general variety test of the preceding year was also conducted, but the culture was so badly attacked by worms that there was no harvest. Some results were obtained from the crop rotation test planted to Binicol. The land was plowed when the plants were seen to be past recovery.

In the head-to-the-row test of Kinastila the low yield was attributed to the attacks of worms. The highest yields were from 1,238 to 1,760 kilos per hectare, which is equivalent to 28.39 and 40.59 cavans. High yields were found to be correlated with the highest average number of culms per stool and grains per head, and also with the length of the panicles.

The seeding experiments showed that planting too many seeds to the hill gave no appreciable increase in the production of upland palay. Planting 3 to 4 seeds to each hill gave a good development of the plants with stout culms and long panicles, thus giving a high yield of grain. Dropping too many seeds is a mere waste of seed materials and the plants produced are slender and weak, hardly able to produce panicles. In this test 2,465.76 kilos was obtained per hectare by dropping three seeds only to each hill, and 2,183.74 kilos, with four seeds to each hill. Lower and lower yields were obtained as the number of seeds dropped were increased.

Planting upland rice deeper than 3 centimeters resulted in low percentage and delayed dates of germination, and in attacks by ants and other pests.

Monthly seasonal plantings were also conducted in order to find out in what months upland rice could be planted with a promise of good harvest. Plantings made during May and

June gave good results. Other plantings made during the year gave very poor results, especially those of January, February, March, and April. To keep the selected seeds viable until the next planting season is of vital importance to the farmers. In the tests made, properly dried seeds kept in cloth bags, paper bags and air-tight containers up to the eleventh month, gave 60, 54, and 50 per cent germination, respectively. When other methods were employed the viability of the seed was soon lost.

1927

General variety test.—A newly opened field was used for carrying out the variety test of upland rice, which took in 93 varieties. The rice was planted on June 22 and 23, 1927, a time too late for planting upland rice because of the lack of laborers for preparing the land. However, very good crops were obtained. Of those tested, the Kinastila, Dinolores, Mocal, Inangel, Sinampiro, Kabuyok, Quinamantigue, Agri-Luya, Dinalaga and Pileng Baybay gave the highest yields, which varied from 50 to 63.13 cavans to the hectare. The other varieties yielded only from 4.39 to 49.43 cavans. The early maturing and aromatic varieties gave very low or no yields at all because they were very susceptible to the attacks of rats, bats, "maya," "atangia," etc. The Bhuang Ngern, Kao Chao Hom and Caviteña were found to be lowland varieties. The Nagako Shrinriki, K. A. C. No. 109 and K. A. C. No. 722 did not germinate at all. Considering all the expense involved in carrying out the test, the cost of production totaled ₱123.68 per hectare.

Of the special variety test of upland rice which covered four varieties, the Kinastila again led, with a yield of 58.31 cavans to the hectare, followed by Dinolores with a yield of 48.51 cavans at a cost of production of ₱86.74.

The seeds harvested from the five highest yielding rows in the head-to-the-row test of Kinastila the preceding year were planted in five different plots of equal area to test further which would give the highest yield and to multiply the strains; but the cultures did not produce any grain because of the pests that attacked the plants during the heading stage. Efforts were made to save the strains, but were futile.

To verify the results so far obtained from our seeding experiment on upland rice and to make it conclusive, a culture for this test was carried out. Favorable results were obtained from the planting of 3 and 4 seeds to the hill, with a yield of 2,566.67 and 2,300 kilos to the hectare, respectively. The plants produced

from placing 6, 7, 8, 9 and 10 seeds to the hill were slender, developed no culms and produced poor short panicles. The plants resulting from sowing one and two seeds to the hill were vigorous, producing plenty of culms with long heavy panicles. The 3- and 4-seed method proved the better of the two.

TABLE X.—*Summary of variety tests of upland rice at the Lamao Experiment Station for the period 1921–24*

Number	Variety name	Yield per hectare in kilos				Average yield per hectare
		1921	1922	1923[a]	1924	
777	Sagoboy	1,300	276			788.00
1320	Guinamat	760	232			496.00
1226	Mangasa I		96		92.22	94.11
1110	Mangasa II	1,100			805.56	952.78
	Mangasa III				780.00	780.00
1485	White Mangasa	760	502			631.00
1324	Kinacao	1,100	454		906.62	1,230.33
1342	Ngapol	1,120	184			652.00
1327	Kinilay	1,020	444			732.00
1329	Malagoso	900				900.00
260	Caporcas I	920	128			524.00
1334	Pilit Morado	1,040	540			790.00
1318	Galong Famy	560				560.00
1314	Cuoab	680	238			459.00
1048	Inintiw	800	444		273.33	505.77
1049	Macan II	580				580.00
1244	Cainti	680				680.00
1319	Galong Santa Maria	1,000				1,000.00
1326	Kinanda	1,320	196			758.00
644	Nagsayang pula	1,500	728		1,334.44	1,187.48
966	Daliket	1,060			95.56	577.78
520	Lubang pula	1,160	356			758.00
1332	Naglantik	1,160	584			872.00
1103	Lubang blanco	1,280	636			958.00
1139	San Fabian	1,180	408			794.00
282	Caririt	700	456			578.00
1302	Binagacay	560	428			494.00
1216	Kinandang pula	740	256		568.89	521.63
205	Colapdos	640	596			618.00
262	Capotol	2,020	1,000			1,510.00
1311	Carabao	180				180.00
448	Inaslom	1,040				1,040.00
613	Mayoro I	1,040	186		831.11	685.70
1181	Pol-lique	1,700				1,700.00
1237	Binalintin	580				580.00
1321	Guinan	580	668			624.00
1284	Guinaboc	1,520	514			1,017.00
1312	Capayong	940				940.00
120	Bulagsac or Binulagsac	760			1,016.67	888.33
	Bulao	1,368				1,368.00
1304	Binongang Loay	1,360	922			1,141.00
1361	Binoguinguin	1,020	648			834.00
620	Minantica I	640			430.00	535.00
	Minantica II				714.44	714.44
572	Malido	680	764			722.00
1339	Tonguitan	1,380	228			804.00
1489	Inantak	1,160	596			878.00
1299	Bayangbang	1,740	446			1,093.00
1279	Bandera	800				800.00
229	Calonod	540	386			463.00
1335	Quinirispinong Puti	1,020	510		841.11	790.37
1313	Carawin	2,020	650			1,335.00
1308	Caluis	560				560.00
980	Kinastila IV	920				920.00
1050	Kinastila V		408		1.630.00	1,019.00
1193	Kinastila VII		86			86.00
1309	Caña Bombo	1,600	446			1,023.00
338	Dali	880				880.00
1341	Buaoa	1,000	298			649.00
78	Binagontauo	1,000				1,000.00
1364	Binagontauo		608		817.78	712.89

[a] Mature plants carried away by flood.

TABLE X.—*Summary of variety tests of upland rice at the Lamao Experiment Station for the period 1921–24*—Continued

Number	Variety name	Yield per hectare in kilos				
		1921	1922	1923 [a]	1924	Average yield per hectare
1330	Layag	960	150			555.00
347	Dap-pog	580				580.00
67	Binabaye II	1,040	538			789.00
1383	Menita	940	314			627.00
346	Kinalangkang	740				740.00
1343	Quinokong uwak	1,160	56			608.00
1340	Unoy Dagoydoy	860	232			546.00
1317	Dinolores	780	182		961.11	641.03
1097	Initlog-dalag	420				420.00
	Piniling Malatiit	580				580.00
1332	Guimat	1,220	130			675.00
1004	Roxas	1,240				1,240.00
956	Inantipolo II	680	274		1,151.11	701.70
1217	Kinandang puti	640	252			446.00
1333	Luyot	900	144			522.00
958	Macatibos I	1,040	404			722.00
	Cabijud	640				640.00
1353	Aikoku	1,580	558			1,069.00
306	Catorsa	560	232			396.00
987	Magdalena		460			460.00
1213	Inagsaya		218			218.00
639	Nagdami		368			368.00
1331	Mita				722.22	722.22
1298	Ban-ar		270			270.00
1188	Sekitori					
1249	Nagrion		292			292.00
1166	Kinandang kumpol		116			116.00
1230	Naglihim		394			394.00
362	Dinagat I				452.22	452.22
619	Mantica Pilit		610			610.00
1252	Bangol		276			276.00
879	Tinomanan					
1565	Quinamantigue		378			378.00
1315	Danilog		204			204.00
515	Lubang II		340			340.00
1305	Cabayo		560			560.00
1500	Macapno		302			302.00
47	Barangcal		342			342.00
1338	Tapacoy		450			450.00
1351	Oyoy		270			270.00
1348	Cadidi		224			224.00
1001	Apostol		456			456.00
1147	Cutsiam II		230			230.00
999	Hinirang		642			642.00
1100	Lampadan or Allangigan		832			832.00
1490	Sinaria		676			676.00
951	Kalibod		328			328.00
126	Bulandi		480			480.00
1285	Kinampupoy		386			386.00
1250	Thul Chalong		376			376.00
1325	Kinayabog		416			416 00
774	Sacsek		856			856.00
	Check		514			514.00
1347	Caviteña a Biit		304			304.00
1146	Casulig		234			234.00
1148	Tuhao III or Caot		282			282.00
943	Bonguet		164			164.00
991	Malagkit-Kaawa		244			244.00
1564	Malagkit				502.22	502.22
1133	Samban		152			152.00
1386	Panay		234			234.00
1149	Bagsang		192			192.00
1125	Pinili a Biit	520	414			467.00
574	Maliro		548			548.00
1316	Dayome		470			470.00
1231	Nagoyon		648			648.00
254	Capichola		358			358.00
1073	Calibog		420			420.00
1323	Inacopanga		280		1,124.44	702.22
990	Kaawa		526		270	398.00
1328	Check		588			588.00
530	Macan Piña		244			244.00

[a] Mature plants carried away by flood.

TABLE X.—*Summary of variety tests of upland rice at the Lamao Experiment Station for the period 1921-24*—Continued

Number	Variety name	Yield per hectare in kilos				
		1921	1922	1923[a]	1924	Average yield per hectare
92	Binicol I	.....	170	.....	.....	170.00
937	Binicol II	1,260	248	.....	1,605.56	1,037.85
1289	Amariles	.....	252	.....	.....	252.00
1337	Sarocot	.....	186	.....	.....	186.00
1301	Bihoralog pula	.....	108	.....	.....	108.00
998	Macarañag II	.....	192	.....	780.00	486.00
1561	Lintang anod	.....	104	.....	.....	104.00
1300	Berilhon	.....	476	.....	.....	476.00
979	Nagpunit	.....	602	.....	.....	602.00
1387	Pinalengke	.....	390	.....	.....	390.00
1234	Piniling Bebay	.....	356	.....	.....	356.00
673	Piling Baybay	.....	226	.....	677.78	451.89
1136	Sinaba III	.....	312	.....	.....	312.00
1101	Langauisan	.....	362	.....	.....	362.00
1310	Caponguit	.....	570	.....	.....	570.00
1138	Sinampaga	.....	764	.....	175.56	469.78
1320	Check	.....	448	.....	.....	448.00
971	Kinastaño II	.....	664	.....	.....	664.00
969	Binucawe	.....	192	.....	.....	192.00
967	Binondoc II	.....	230	.....	.....	230.00
724	Putyucanon	.....	228	.....	.....	228.00
New	Guinolong	.....	154	.....	.....	154.00
New	Pinursigue	.....	758	.....	196.67	477.33
1294	Gopher	.....	524	.....	.....	524.00
1295	Storm Proof	.....	722	.....	.....	722.00
New	Sinantamaria	.....	286	.....	.....	286.00
	Guininto	.....	.....	.....	806.66	806.66
	Sanglay	.....	.....	.....	330.00	330.00
	Agri-Luya	.....	.....	.....	1,108.89	1,108.89
	Kinamalig	.....	.....	.....	984.44	984.44
	Binohangin	.....	.....	.....	287.78	287.78
	Sinadyaya	.....	.....	.....	50.00	50.00
	Vinirgin	.....	.....	.....	592.22	592.22
	Dinalaga	.....	.....	.....	1,145.56	1,145.56
	Dinulis	.....	.....	.....	1,708.89	1,708.89
	Inusim	.....	.....	.....	1,294.44	1,294.44
	Delitos	.....	.....	.....	488.89	488.89
	Pauni	.....	.....	.....	1,112.22	1,122.22
	Macan pulo	.....	.....	.....	310.00	310.00
	Inabaca	.....	.....	.....	335.56	335.56
	Buric	.....	.....	.....	757.78	757.78
	Buluhan	.....	.....	.....	260.00	260.00
	Kinawayan	.....	.....	.....	162.22	162.22
	Tapuy	.....	.....	.....	10.00	10.00
	Nagkayat	.....	.....	.....	117.78	117.78
	Inangel	.....	.....	.....	350.00	350.00
	Buliro	.....	.....	.....	75.56	75.56
	Quinate	.....	.....	.....	247.78	247.78
	Dumali	.....	.....	.....	220.00	220.00
	Malagkit Macapilay Pusa	.....	.....	.....	186.67	186.67
	Pirurutong	.....	.....	.....	704.44	704.44
	Tintanos	.....	.....	.....	837.78	837.78
	Tangi Sinampay Bacod	.....	.....	.....	492.22	492.22

[a] Mature plants carried away by flood.

PARA RUBBER IN MINDORO

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Horticulturist

With the appropriation of ₱65,000 made available by Act No. 3230 during the latter part of 1925, the Bureau of Agriculture was able to conduct various tapping experiments on the Para rubber trees at the Halcon Rubber Plantation, Baco, Mindoro, beginning May 25, 1926. This plantation can be reached in about two or three hours by banca from Baruyan, Calapan, Mindoro.

OBJECTS

The main aim of the experiments was to find out the yield of Para rubber trees in the typhoon belt with a well-distributed rainfall throughout the year under the following conditions:

1. Tapping intervals
2. Comparison of the different methods of tapping
3. Comparative production of tapping once and twice a day
4. Thickness of bark shavings
5. Tapping angles
6. Tapping heights
7. Comparative cost of tapping Para rubber on level and hilly land
8. Fertilizer test
9. Selection work

CLIMATE AND SOIL

The western part of Mindoro usually has two very pronounced seasons: dry in winter and spring, wet in summer and autumn, while the eastern side has no pronounced maximum rainy period and no dry season. The Halcon Rubber Plantation, where the experiments are being undertaken is located in the northeastern part of Mindoro and this portion of the island has a rainfall of uniform distribution throughout the year, the rain falling mostly in the afternoon and evening, which is very favorable to the growing of Para rubber tree. Mindoro as a whole is within the typhoon belt, but the plantation is semi-protected from the strong winds on the eastern and southern parts by Mount Halcon and a low hill surrounds part of the area cultivated to rubber, except in the northern part toward Sabaang Bay.

The land occupied by the Para rubber trees is partly a steep hill and partly a level plain. The soil in general is rather deep

and of medium clay on the level plain and clay loam on the hilly portion. The level plain near the barrio of Lumang-Bayan is poorly drained, and it is believed that this condition is partly responsible for the poor development of the trees in that section of the plantation. The results of the chemical and mechanical analyses made by the Bureau of Science of the soil samples submitted by the Bureau of Agriculture are given below:

CHEMICAL ANALYSIS OF SURFACE SOIL

(Water-free basis)

	Per cent
Loss on ignition	6.768
Nitrogen (N_2)	1.652
Phosphoric anhydride (P_2O_5)	0.595
Lime (CaO)	1.131
Potash (K_2O)	1.315
Humus	0.852
Soil acidity (per cent $CaCO_3$)	0.678

MECHANICAL ANALYSIS

	Surface soil Per cent	Subsoil Per cent
Detritus not passing 1 mm. sieve	4.3	4.5
1. Coarse sand 1–0.5 mm.	3.9	3.6
2. Medium sand 0.5–0.25 mm	7.2	7.3
3. Fine sand 0.25–0.10 mm	10.9	12.8
4. Very fine sand 0.10–0.05 mm	27.9	26.8
5. Silt 0.05–0.005 mm	39.5	37.7
6. Clay 0.003 mm	10.6	11.8
Total from 1 to 6	100.00	100.0

MATERIALS USED

The Para rubber trees under experiment are said to have been planted sometime in 1913 or 1914, and not less than 10,000 seedlings were originally set out, according to information obtained from people in the locality. Out of this number about 4,000 had reached the tapping age when the plantation was abandoned years ago. As a result of this many of the trees were cut down by the natives in the vicinity while clearing a portion of the plantation for "caingin" planting.

There were more or less 1,000 Para rubber trees found living after the clearing of the plantation done by the Bureau of Agriculture in 1926, and these were scattered over about 4 or 5 hectares of land. There are no indications whatsoever on the surviving trees to show that previous tapping had been done on the plantation. At the start of the experiments, May 25, 1926, the girths of the rubber trees varied from 16 to 65 inches

measured three feet from the ground. The trees were practically all in excellent condition except those on the plain near the barrio of Lumang-Bayan, which portion of the plantation is poorly drained; and those along the trail, where trees had been badly hacked by the passers-by and the boys in obtaining rubber for balls. These injured trees have grown with knotted bark and are therefore difficult to tap.

Before the plantation was abandoned it is said that the trees were kept clean by constant weeding on which work a considerable sum was expended. Since May 25, 1926, when the Bureau of Agriculture's work began there, the trees have been cleaned of weeds around their trunks from time to time, and the weeds between the rows of trees cut down once in a while to facilitate the gathering of the fallen seeds as well as the tapping of the trees and the collection of the latex.

No serious pest has so far been found attacking the Para-rubber trees in Mindoro, and in general the trees look healthy. However, a few trees were found to be infected with canker, *Phytophthora faberi* and collar rot, *Ustulina zonata,* but neither disease is considered serious in the rubber-growing countries. The former occurs mostly on poorly drained soil, and during the dry period it disappears. The collar rot is only a result of neglect after pruning, or after a wind has broken off the branches, or when dead wood has been left lying about the plantation. Painting the stump left with lead acetate after removing the affected parts has been found very effective.

METHODS

The land where the trees are selected for experimental purposes is divided into blocks and sections to suit the experiments. The trees have been numbered, marked and opened for tapping; and cup holders, spouts and collecting cups provided for each of the trees under experiment.

The latex collected from each of the trees in a block after it has been measured and recorded is mixed together in one bucket. The collecting cups are then washed and hung on a pole near the tree to get dry for the following tapping. The wash water is also collected in a bucket separate from that for the pure latex. The latex and wash water from the different experimental blocks are coagulated in separate pans after they have been sieved twice—once through a netted wire and then through a cheese cloth— to remove the impurities, such as leaves, branches, scrap rubber, etc. A 20 per cent solution of acetic acid is used in coagulating the latex and the wash water. After the addition

of the necessary acid to the latex and wash water the mixture is stirred well with a small bamboo or wooden paddle in order to mix the acid properly with the latex or wash water as the case may be. Then it is poured into enameled pans and left to settle until the following day, when the coagulum is kneaded with a wooden implement to remove all the water possible. This is now replaced by a small hand rubber roller. After this process the coagulum, which is now in the form of a small sheet, is hung on a wooden rack outside in the sun for a few hours to let the water adhering to it drip off. It is then weighed as wet rubber. Afterwards the rubber sheet is dried inside of the smokehouse till its constant weight is attained, which is recorded as weight of dry rubber. Smoking is usually carried on from 2 p. m. to 9 a. m. every day for about ten consecutive days, especially during the rainy days. The rubber produced from the latex and wash water, and the tree scrap are separately weighed and recorded as No. 1, 2, and 3 rubber. The daily production for each of the experiments is obtained by getting the total weights of rubber No. 1, 2 and 3 produced from the latex, wash water and tree scrap for that day on each of the blocks and calculating accordingly as per the latex production of each of the conditions called for in the experiment.

To prevent the rapid oxidation of the latex, a general cleaning of the spouts and collecting cups is done occasionally.

RESULTS

The results presented consist of the data obtained from the following experiments:

1. Tapping intervals
2. The different methods of tapping
3. The comparative production of tapping once and twice a day
4. The tapping heights
5. The individual yield records of the trees

The data so far gathered from the other experiments are inconclusive.

The relative merits of the different tapping intervals cut half-spiral to the left from May 31, 1926, to August 31, 1927 are shown in Table I.

(*a*) A small hand rubber roller in operation at the Halcon Rubber Sub-station, Baco, Mindoro

(*b*) A wooden rack where rubber sheets are being dried for a few hours at the Halcon Rubber Sub-station, Baco, Mindoro

TABLE I.—*Tapping intervals*

Tapping intervals	May 31–June 30, 1926			July, 1926			August, 1926		
	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber
			Kilos			*Kilos*			*Kilos*
Daily	26	22.860	10.904	27	21.089	10.460	27	33.389	12.955
Alternate daily	14	6.102	2.911	14	10.234	5.076	12	9.420	3.655
Every two days									
Every three days									
Every four days									
Every five days									
Every six days									
Alternate weekly	13	5.976	2.851	15	8.077	4.006	15	6.808	2.642
Alternate bi-weekly	15	7.278	3.472	14	7.541	3.740	13	11.694	4.537
Alternate tri-weekly	17	5.728	2.732	18	2.962	1.469	18	2.020	0.784
Alternate monthly	26	13.974	6.666				28	18.971	7.361
Every six months									
Total	111	61.918	29.536	88	49.903	24.751	113	82.302	31.934

Tapping intervals	September, 1926			October, 1926			November, 1926		
	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber
			Kilos			*Kilos*			*Kilos*
Daily	25	30.685	10.402	26	28.669	10.206	20	22.399	8.332
Alternate daily	12	8.731	3.060	12	7.534	2.682	10	9.158	3.406
Every two days							9	5.872	2.184
Every three days							11	8.845	3.290
Every four days							11	8.896	3.309
Every five days							10	6.524	2.427
Every six days							9	3.972	1.478
Alternate weekly	12	6.887	2.335	13	5.061	1.802	13	8.036	2.979
Alternate bi-weekly	12	6.789	2.301	14	7.444	2.650	9	5.522	2.054
Alternate tri-weekly	11	3.072	1.041	18	5.429	1.933	11	2.497	0.929
Alternate monthly				27	19.461	6.928			
Every six months							20	12.440	4.628
Total	72	56.164	19.139	110	73.598	26.201	133	94.161	35.016

Tapping intervals	December, 1926			January, 1927			February 1927		
	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber
			Kilos			*Kilos*			*Kilos*
Daily	17	16.381	5.602	26	28.207	9.732	24	20.511	7.199
Alternate daily	7	4.919	1.682	12	9.776	3.373	11	4.718	1.656
Every two days	8	4.843	1.656	15	7.073	2.440	14	5.002	1.756
Every three days	9	5.410	1.850	13	7.426	2.562	9	4.093	1.437
Every four days	6	4.178	1.429	14	9.540	3.291	14	8.886	3.119
Every five days	9	4.688	1.603	15	9.161	3.161	12	8.493	2.981
Every six days	10	4.843	1.656	10	3.998	1.379	12	4.272	1.499
Alternate weekly	12	6.908	2.363	13	7.162	2.471	13	5.048	1.772
Alternate bi-weekly	9	6.051	2.069	11	7.720	2.663	12	5.962	2.093
Alternate tri-weekly	6	1.725	0.590	13	4.379	1.511	19	2.832	0.994
Alternate monthly	18	12.048	4.120				24	16.103	5.652
Every six months	18	9.003	3.079	26	11.434	3.945	24	10.819	3.797
Total	129	80.997	27.699	168	105.876	36.528	188	96.739	33.955

TABLE I.—*Tapping intervals*—Continued

Tapping intervals	March, 1927			April, 1927			May, 1927		
	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber	Tapping days	Latex in liters	Dry rubber
			Kilos			*Kilos*			*Kilos*
Daily	25	36.071	13.491	27	20.748	7.511	25	26.005	9.336
Alternate daily	14	8.653	3.236	13	7.073	2.560	13	9.360	3.360
Every two days	13	3.808	1.424	15	4.515	1.634	14	5.086	1.826
Every three days	11	3.667	1.371	14	4.029	1.458	12	3.576	1.284
Every four days	12	6.772	2.543	14	4.254	1.540	15	5.379	1.931
Every five days	12	7.381	2.760	11	6.123	2.217	10	5.981	2.147
Every six days	14	2.663	0.996	12	1.818	0.658	12	2.362	0.848
Alternate weekly	12	5.345	1.999	12	4.318	1.563	12	7.329	2.631
Alternate bi-weekly	13	8.327	3.114	13	5.434	1.967	13	7.179	2.577
Alternate tri-weekly	8	2.378	0.889	8	2.817	1.020	20	5.291	1.899
Alternate monthly	.....	.....	.....	27	18.692	6.762	.....	.....	.....
Every six months	25	9.112	3.408	26	7.797	2.823	.....	.....	.....
Total	159	94.177	35.231	192	87.618	31.713	146	77.548	27.839

Tapping intervals	June, 1927			July, 1927			August, 1927		
	Taping days	Latex in liters	Dry rubber	Taping days	Latex in liters	Dry rubber	Taping days	Latex in liters	Dry rubber
			Kilos			*Kilos*			*Kilos*
Daily	28	14.836	6.053	23	10.552	3.778	23	21.012	9.098
Alternate daily	14	7.477	3.050	12	7.629	2.731	12	5.864	2.539
Every two days	14	5.208	2.125	14	7.334	2.626	13	6.034	2.613
Every three days	12	4.043	1.649	13	5.769	2.065	13	3.411	1.477
Every four days	11	3.877	1.582	15	9.866	3.532	12	7.463	3.231
Every five days	14	5.654	2.307	14	8.668	3.103	8	5.467	2.367
Every six days	10	2.289	0.934	13	5.324	1.907	9	1.419	0.614
Alternate weekly	16	5.816	2.373	13	5.724	2.049	10	3.693	1.599
Alternate bi-weekly	16	6.296	2.569	14	8.024	2.873	15	7.852	3.300
Alternate tri-weekly	20	4.042	1.649	8	1.385	0.496	10	1.410	0.611
Alternate monthly	28	16.051	6.549	.....	.....	.....	23	12.815	5.549
Every six months	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	183	75.589	30.840	139	70.275	25.160	148	76.440	32.998

Tapping intervals	Actual yield			Number of days tapped	Number of trees tapped
	Latex in liters	Dry rubber			
		Total	Per tree		
		Kilos	*Kilos*		
Daily	353.414	135.059	3.972	369	34
Alternate daily	116.648	44.977	1.406	182	32
Every two days	54.775	20.284	0.845	129	24
Every three days	50.269	18.443	0.768	117	24
Every four days	69.111	25.507	1.063	124	24
Every five days	68.140	25.073	1.045	115	24
Every six days	32.960	11.969	0.499	111	24
Alternate weekly	92.188	35.435	1.107	194	32
Alternate bi-weekly	109.113	41.979	1.312	193	32
Alternate tri-weekly	47.967	18.547	0.580	205	32
Alternate monthly	128.115	49.587	1.550	201	32
Every six months	60.605	21.680	0.903	139	24
Total	1,183.305	448.540	15.050	2,079	338

TABLE I.—*Tapping intervals*—Continued

Tapping intervals	Average girth 3-feet from ground	Rainy days
	Inches	
Daily	37.32	79 rainy days and no tapping was practicable.
Alternate daily	33.49	39 rainy days and no tapping was practicable.
Every two days	26.00	23 rainy days and no tapping was practicable.
Every three days	26.87	33 rainy days and no tapping was practicable.
Every four days	28.87	29 rainy days and no tapping was practicable.
Every five days	34.89	32 rainy days and no tapping was practicable.
Every six days	27.26	39 rainy days and no tapping was practicable.
Alternate weekly	26.41	21 rainy days and no tapping was practicable.
Alternate bi-weekly	28.57	17 rainy days and no tapping was practicable.
Alternate tri-weekly	24.32	
Alternate monthly	35.43	40 rainy days and no tapping was practicable.
Every six months	32.08	44 rainy days and no tapping was practicable.
Total	338.99	

Tapping at two-, three-, four-, five-, six-day and six-month intervals began October 29, 1926; and daily, alternate daily, weekly, bi-weekly, tri-weekly and monthly on May 31, 1926.

The highest yielding months of the different tapping intervals were March and August for the daily tapping, July and August for the alternate day, July and August for the two-day, November and January for the three-day, July and November for the four-day, January and July for the five-day, July and December for the six-day, July and November for the weekly, June and August for the bi-weekly, June and October for the tri-weekly, August and October for the monthly, and January and November for the six-month intervals. The highest yield and rubber content per liter of latex were obtained during July and August. However, during the month of June, a rubber content of 0.477 kilogram per liter of latex was also obtained as compared with 0.496 and 0.433 kilogram for July and August, respectively, but the yield was less than that of July and August because of less latex produced during the month.

Of the various tapping intervals that were tried during the period, the daily tapping gave the highest total yield for the whole period, the alternate month second, the alternate day third and the bi-weekly fourth. The corresponding yields were 135.059, 49.587, 44.977, and 41.979 kilograms of dry rubber, respectively, or equivalent to 3.972, 1.55, 1.406 and 1.312 kilograms of dry rubber per tree for the whole period.

The effect of the brown-bast, which has been reported to be mainly due to the excessive tapping of Para rubber, has so far not yet been observed on the trees in the plantation even on those tapped daily.

The trees in the alternate weekly and tri-weekly sections gave lower yields, probably owing to the severe injury done to them by people and animals, and their bark has become rather knotty and difficult to tap. Besides the land where the trees are planted is rather poorly drained. The trees in the alternate daily, alternate bi-weekly, alternate monthly and those trees tapped daily have also suffered injury in the same manner although not so severe as the other two sections; namely, the alternate weekly and tri-weekly sections.

Table II shows the monthly yields obtained from the different tapping systems from July 1926 to August 1927.

TABLE II.—*Tapping system*

Month	Half-spiral							
	Daily				Alternate daily			
	Number of trees	Days tapped	Latex	Dry rubber	Number of trees	Days tapped	Latex	Dry rubber
			Liters	*Kilos*			*Liters*	*Kilos*
July 1926	44	26	41.563	14.921	44	12	22.257	7.990
August 1926	44	28	45.059	15.635	44	15	38.533	13.371
September 1926	44	25	27.768	9.330	44	13	19.490	6.549
October 1926	44	25	18.945	6.896	44	11	15.193	5.530
November 1926	44	18	21.498	7.395	44	8	13.794	4.745
December 1926	44	18	17.217	5.733	44	8	14.537	4.841
January 1927	44	26	29.199	9.490	44	12	27.304	8.874
February 1927	44	24	29.186	9.719	44	11	22.312	7.430
March 1927	44	25	20.066	7.184	44	14	17.354	6.213
April 1927	44	27	15.322	5.225	44	13	10.834	3.694
May 1927	44	25	18.199	6.297	44	12	13.888	4.805
June 1927	44	26	8.429	2.874	44	12	16.154	5.509
July 1927	44	26	20.013	6.744	44	14	15.747	5.307
August 1927	44	23	14.382	6.026	44	10	7.724	3.236
Total	616	342	326.846	113.469	616	165	255.121	88.094

Month	Half-spiral				V-shaped					
	Total yield				Daily				Alternate daily	
	Number of trees	Days tapped	Latex	Dry rubber	Number of trees	Days tapped	Latex	Dry rubber	Number of trees	Days tapped
			Liters	*Kilos*			*Liters*	*Kilos*		
July 1926	88	38	63.820	22.911	47	26	87.812	31.525	47	12
August 1926	88	43	83.592	29.006	47	28	32.944	11.432	47	15
September 1926	88	38	47.258	15.879	47	25	14.867	4.995	47	13
October 1926	88	36	34.138	12.426	47	25	13.444	4.894	47	11
November 1926	88	26	35.292	12.140	47	18	8.280	2.848	47	8
December 1926	88	26	31.754	10.574	47	18	5.364	1.786	47	8
January 1927	88	38	56.503	18.364	47	26	9.564	3.108	47	12
February 1927	88	35	51.498	17.149	47	24	14.780	4.922	47	11
March 1927	88	39	37.420	13.397	47	25	21.187	7.585	47	14
April 1927	88	40	26.156	8.919	47	27	24.437	8.333	47	13
May 1927	88	37	32.087	11.102	47	25	31.207	10.798	47	12
June 1927	88	38	24.583	8.383	47	26	13.999	4.674	47	12
July 1927	88	40	35.760	12.051	47	26	33.357	11.241	47	14
August 1927	88	33	22.106	9.262	47	23	22.960	9.620	.....	.....
Total	1.232	507	581.967	201.563	658	342	334.202	117.761	611	155

TABLE II.—*Tapping system*—Continued

Month	V—Shaped						Opposite—V			
	Alternate daily		Total yield				Daily			
	Latex	Dry rubber	Number of trees	Days tapped	Latex	Dry rubber	Number of trees	Days tapped	Latex	Dry rubber
	Liters	*Kilos*			*Liters*	*Kilos*			*Liters*	*Kilos*
July 1926	45.704	16.408	94	38	133.516	47.933	.....	.....	.....	.....
August 1926	37.934	13.163	94	43	70.878	24.595	.....	.....	.....	.....
September 1926	15.103	5.075	94	38	29.970	10.070	.....	.....	.....	.....
October 1926	14.108	5.135	94	36	27.552	10.029	.....	.....	.....	.....
November 1926	9.725	3.345	94	26	18.005	6.193	.....	.....	.....	.....
December 1926	5.006	1.667	94	26	10.370	3.453	.....	.....	.....	.....
January 1927	7.269	2.362	94	38	16.833	5.470	40	13	14.072	4.573
February 1927	3.311	1.103	94	35	18.091	6.025	40	24	34.261	11.409
March 1927	2.403	0.860	94	39	23.590	8.445	40	25	24.518	8.777
April 1927	1.534	0.523	94	40	25.971	8.856	40	27	18.752	6.394
May 1927	1.897	0.656	94	37	33.104	11.454	40	25	19.830	6.861
June 1927	3.385	1.154	94	38	17.384	5.828	40	26	24.637	8.401
July 1927	6.286	2.118	94	40	39.643	13.359	40	26	24.235	8.167
August 1927	(a)	(a)	47	23	22.960	9.620	40	23	12.754	5.344
Total	153.665	53.569	1.269	497	487.867	171.330	320	189	173.059	59.926

[a] Rested.

Comparing the yields of 44 trees each of the half-spiral with an average girth of 29.85 inches three feet from the ground and the V-shaped cut with an average girth of 33.51 inches both tapped daily, it was found that the former system yielded 113.469 kilos of dry rubber during the fourteen months or 342 tapping days against 110.244 kilos by the V-shaped method, or an increase of 3.225 kilos over the latter. In the alternate day tapping, however, the 44 trees tapped half-spiral with an average girth of 32.22 inches yielded 37.942 kilos of dry rubber more than the 44 trees tapped V-shaped with an average girth of 27.93 inches during the period of 165 and 155 tapping days, respectively. Taking the total yields of the 44 trees with an average girth of 31.03 inches tapped in half-spirals and the 47 trees with an average girth of 30.72 inches tapped by the V-shaped method both daily and alternate daily, the former gave 30.233 kilos of dry rubber more than the latter system. During the course of the experiment it was noticed that the monthly yields by the half-spiral was almost regular while the V-shaped declined gradually until most of the trees especially those tapped alternate days had to be given a rest because of latex exhaustion. Besides the general health condition of the trees became very poor due to the greater injury received by the trees tapped by the V-shaped sytem. Nevertheless no brown-bast has so far been found on the trees. The bark consumption and the cost of tapping of the trees by the V cut was so great that this system is not recommended in estate practice.

As to the yield of the 40 trees tapped daily in opposite V's with an average girth of 26.20 inches when compared with the yields of the same number of trees tapped daily in half-spiral and V-shaped cuts, the opposite V's yielded 59.926 kilos of dry rubber during the eight months or 189 tapping days, while the half-spiral and the V-shaped gave only 48.651 and 51.307 kilos of dry rubber, respectively, in 202 tapping days. The two V's were opened in opposite directions on the trunk of each tree, one being placed one foot and the other three feet from the ground. Each of the opposite V's was tapped on alternate days, but the trees were tapped daily.

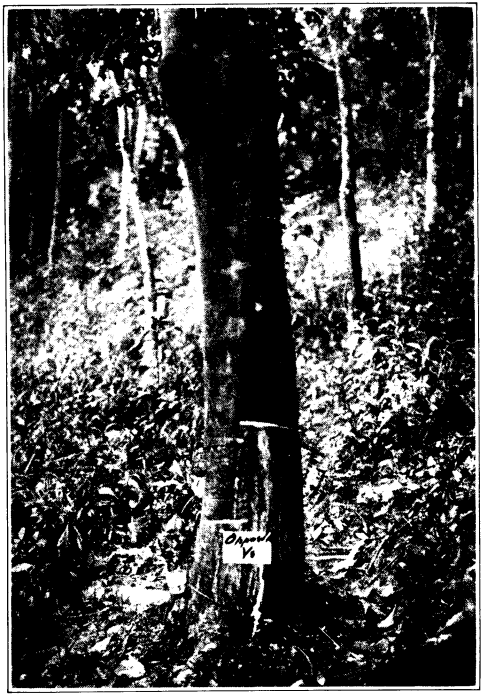
Table III gives the results obtained from the trees tapped once and twice a day from July 1926 to August 22, 1927.

The average girths measured three feet from the ground of the trees in the experiment were as follows:

32.77 inches of the trees tapped daily and twice a day incisions
25.87 inches of the trees tapped alternate days and twice a day incisions
33.44 inches of the trees tapped daily in the afternoon
32.27 inches of the trees tapped alternate days in the afternoon
29.85 inches of the trees tapped daily in the morning
32.22 inches of the trees tapped alternate days in the morning

The highest rubber content per liter of latex was obtained during the month of August under all conditions of the experiment, or 0.419 kilo for the morning tapping, 0.3942 kilo for the afternoon tapping both tapped once a day, and 0.4619 and 0.6021 kilo for tapping twice a day—morning and afternoon, respectively. The afternoon tappings of once and twice a day gave higher rubber content than the morning tappings, which averaged 0.3549 kilo per liter of latex for the afternoon tapping once a day and 0.3671 kilo for the afternoon tapping twice a day during the whole period of the experiment against 0.3488 and 0.3159 kilo for the morning tappings once and twice a day.

Using the half-spiral system of continuous daily tapping once a day only, the yield for the afternoon tapping was comparatively higher than for the morning tapping in spite of the established principle that the morning tapping of Para rubber gives decidedly more latex than that of any other time of the day. The average yield per tree of the trees tapped daily in the afternoon was 3.044 kilos of dry rubber against 2.578 kilos in the morning



(*a*) Para rubber tree tapped in opposite V's at the Halcon Rubber Sub-station, Baco, Mindoro

(*b*) Para rubber tree tapped two feet from the ground at the Halcon Rubber Sub-station, Baco, Mindoro

during the 342 tapping days, while the alternate day tapping gave the yields of 2.002 and 1.989 kilos of dry rubber in favor of the morning tapping during the 165 tapping days. Taking the total average yield of the daily and the alternate day tappings, the yield per tree of the morning tapping was 2.29 kilos of dry rubber and 2.477 kilos for the afternoon tapping during the 507 tapping days, or a difference of 0.187 kilo in favor of the afternoon tapping. It has been observed that if the weather is favorable and tapping is started as late as three o'clock in the afternoon, tapping Para rubber in the afternoon is advisable provided that the latex can be coagulated before night.

Tapping the trees twice a day—morning and afternoon—both daily and alternate days, the morning tappings gave better yields than the afternoon tappings. The total average yield per tree of the morning daily and alternate day tappings was 1.025 during the 348 tapping days, against 0.959 kilo of dry rubber for the afternoon tapping during the 395 tapping days. The yields of the morning tappings alone were 1.205 kilos of dry rubber per tree for the daily and 0.845 kilo for the alternate days during the 227 and 121 tapping days, respectively, while the afternoon tapping yielded only 1.149 and 0.768 kilo of dry rubber during the 260 and 135 tapping days. In this experiment, too, the daily tapping yielded more than that of the alternate days or a difference of 0.371 kilo of dry rubber per tree during the periods of 487 and 256 tapping days in the alternate days.

Comparing the average total yields per tree of the trees tapped once a day in the morning as well as in the afternoon with the yield of the trees tapped twice a day—morning and afternoon—shows that the trees tapped once in the afternoon yielded 1.931 kilos of dry rubber per tree during th 395 tapping days, while those tapped once a day in the morning and twice a day—morning and afternoon—yielded only 1.784 and 0.954 kilos of dry rubber, respectively, during the same number of tapping days. It may therefore be concluded from the present experiment that tapping twice a day is impracticable not only because of the lower yield attained, but also the cost of operation and the possible effect of diseases on the trees due to excessive tapping.

TABLE III.—*Tapping once and twice a day*

ONCE A DAY

Month	Morning tapping—check											
	Daily				Alternate daily				Total yield			
	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber
			Liters	*Kilos*			*Liters*	*Kilos*			*Liters*	*Kilos*
July 1926	44	26	41.563	14.921	44	12	22.257	7.990	88	38	63.820	22.911
August 1926	44	28	45.059	15.635	44	15	38.533	13.371	88	43	83.592	29.006
September 1926	44	25	27.768	9.330	44	13	19.490	6.549	88	38	45.258	15.879
October 1926	44	25	18.945	6.896	44	11	15.193	5.530	88	36	34.138	12.426
November 1926	44	18	21.498	7.395	44	8	13.794	4.745	88	26	35.292	12.140
December 1926	44	18	17.217	5.733	44	8	14.537	4.841	88	26	31.754	10.574
January 1927	44	26	29.199	9.490	44	12	27.304	8.874	88	38	56.503	18.364
February 1927	44	24	29.186	9.719	44	11	22.312	7.430	88	35	51.498	17.149
March 1927	44	25	20.066	7.184	44	14	17.354	6.213	88	39	37.420	13.397
April 1927	44	27	15.322	5.225	44	13	10.834	3.694	88	40	26.156	8.919
May 1927	44	25	18.199	6.297	44	12	13.888	4.805	88	37	32.087	11.102
June 1927	44	26	8.429	2.874	44	12	16.154	5.509	88	38	24.583	8.383
July 1927	44	26	20.013	6.744	44	14	15.747	5.307	88	40	35.760	12.051
August 1927	44	23	14.382	6.026	44	10	7.724	3.236	88	33	22.106	9.262
Total	616	342	326.846	113.469	616	165	255.121	88.094	1,232	507	581.967	201.563

(*a*) Para rubber tree tapped four feet from the ground at the Halcon Rubber Sub-station, Baco, Mindoro

(*b*) Showing a portion of the Para rubber trees planted on a level plain at the Halcon Rubber Sub-station, Baco, Mindoro

Month	Afternoon tapping											
	Daily				Alternate daily				Total yield			
	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber
			Liters	*Kilos*			*Liters*	*Kilos*			*Liters*	*Kilos*
July 1926	64	26	48.939	19.585	63	12	24.202	9.686	127	38	73.141	29.271
August 1926	64	27	50.699	17.603	63	12	31.559	10.957	127	39	82.258	28.560
September 1926	64	28	45.862	15.543	63	13	28.391	9.622	127	41	74.253	25.165
October 1926	64	27	37.794	14.425	63	13	24.341	9.284	127	40	62.135	23.709
November 1926	64	25	59.824	18.294	63	13	36.123	11.046	127	38	95.947	29.340
December 1926	64	26	46.602	14.866	63	13	33.358	10.641	127	39	79.960	25.507
January 1927	64	31	56.430	19.000	63	16	42.029	14.151	127	47	98.459	33.151
February 1927	64	28	56.485	18.996	63	14	33.570	11.290	127	42	90.055	30.286
March 1927	64	31	57.996	20.229	63	16	27.753	9.680	127	47	85.749	29.909
April 1927	64	28	42.663	14.079	63	17	27.451	9.059	127	45	70.114	23.138
May 1927	63	24	27.378	10.064	62	14	21.859	8.035	125	38	49.237	18.099
June 1927	64	24	23.283	8.547	63	12	18.967	6.963	127	36	42.250	15.510
July 1927	64	24	25.168	9.934	63	12	20.666	8.157	127	36	45.834	18.091
August 1927	64	14	14.182	5.591	63	7	10.470	4.127	127	21	24.652	9.718
Total	895	363	593.305	206.756	881	184	380.739	132.698	1,776	547	974.044	339.454

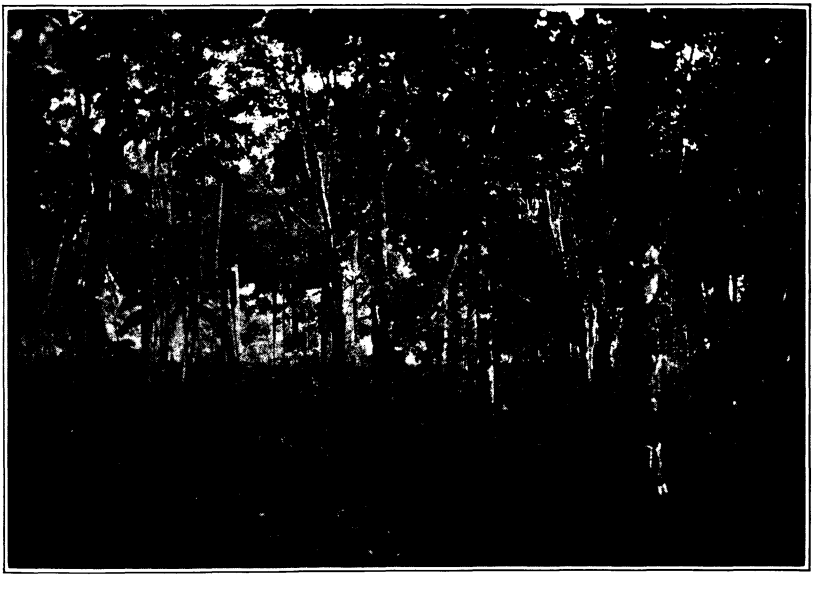
TABLE III.—*Tapping once and twice a day*—Continued

TWICE A DAY

Month	Morning tapping											
	Daily				Alternate daily				Total yield			
	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber
			Liters	*Kilos*			*Liters*	*Kilos*			*Liters*	*Kilos*
October 1926	30	4	1.915	0.692	30	1	0.458	0.165	60	5	2.373	0.857
November 1926	30	19	18.776	6.641	30	10	9.564	3.383	60	29	28.340	10.024
December 1926	30	18	11.829	3.963	30	11	6.795	2.276	60	29	18.624	6.239
January 1927	30	26	17.502	5.208	30	14	10.057	2.992	60	40	27.559	8.200
February 1927	30	23	12.627	3.500	30	13	9.130	2.531	60	36	21.757	6.031
March 1927	30	23	9.726	3.719	30	11	4.488	1.716	60	34	13.214	5.435
April 1927	30	26	6.108	2.173	30	14	6.520	2.320	60	40	12.628	4.493
May 1927	30	22	2.677	0.826	30	13	10.143	3.130	60	35	12.820	3.956
June 1927	30	19	7.494	3.050	30	11	7.918	3.223	60	30	15.412	6.273
July 1927	30	25	11.962	3.486	30	13	8.194	2.388	60	38	20.156	5.874
August 1927	29	22	6.290	2.905	29	10	2.688	1.242	58	32	8.978	4.147
Total	329	227	106.906	36.163	329	121	75.955	25.366	658	348	182.861	61.529

Month	Afternoon tapping											
	Daily				Alternate daily				Total yield			
	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber	Number of trees	Number of days tapped	Latex	Dry rubber
			Liters	*Kilos*			*Liters*	*Kilos*			*Liters*	*Kilos*
October 1926	30	5	2.250	0.887	30	2	0.668	0.263	60	7	2.918	1.150
November 1926	30	23	17.375	4.768	30	13	10.762	2.953	60	36	28.137	7.721
December 1926	30	26	14.170	5.257	30	13	7.998	2.967	60	39	22.168	8.224
January 1927	30	30	15.356	4.902	30	16	10.363	3.308	60	46	25.719	8.210
February 1927	30	27	11.334	3.499	30	15	6.963	2.149	60	42	18.297	5.648
March 1927	30	31	12.245	4.630	30	13	5.554	2.100	60	44	17.799	6.730
April 1927	30	30	6.530	1.916	30	15	6.390	1.875	60	45	12.920	3.791
May 1927	30	23	1.952	0.809	30	14	4.557	1.889	60	37	6.509	2.698
June 1927	30	19	4.660	1.583	30	12	6.519	2.214	60	31	11.179	3.797
July 1927	30	23	9.463	3.243	30	11	5.968	2.045	60	34	15.431	5.288
August 1927	30	23	4.990	3.004	30	11	2.124	1.279	60	34	7.114	4.283
Total	330	260	100.325	34.498	330	135	67.866	23.042	660	395	168.191	57.540

(*a*) Showing a portion of the Para rubber trees planted on hilly ground at the Halcon Rubber Sub-station, Baco, Mindoro



(*b*) A portion of the Para rubber trees tapped in a V-shaped cut at the Halcon Rubber Sub-station, Baco, Mindoro

TABLE IV.—*Tapping heights*

Month (1927)	Two feet					Three feet					Four feet				
	Number of trees	Days tapped	Latex	Dry rubber	Rubber content	Number of trees	Days tapped	Latex	Dry rubber	Rubber content	Number of trees	Days tapped	Latex	Dry rubber	Rubber content
			Liters	*Kilos*	*Per cent*			*Liters*	*Kilos*	*Per cent*			*Liters*	*Kilos*	*Per cent*
January 29 to February 28	15	26	8.556	2.947	34.44	15	26	4.830	2.093	43.33	15	26	8.320	3.210	38.58
March	15	29	7.641	2.934	38.39	15	29	5.167	1.964	38.01	15	29	8.116	3.326	40.98
April	15	27	6.208	1.419	22.85	15	27	3.106	1.180	37.99	15	27	5.709	1.469	25.73
May	15	26	7.888	2.088	26.47	15	26	3.823	1.426	37.30	15	26	6.353	2.064	32.48
June	15	29	5.717	1.789	31.29	15	29	2.097	1.023	48.78	15	29	4.785	1.692	35.40
July	15	24	4.053	1.480	36.51	15	24	2.418	0.883	36.51	15	24	3.782	1.381	36.51
August	15	22	3.384	1.625	48.02	15	22	1.517	0.733	48.31	15	22	2.748	1.059	38.53
Total	105	180	43.447	15.165	237.97	105	180	22.958	9.993	290.20	105	180	39.813	15.082	248.21

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Table IV indicates the results obtained from the trees tapped daily at different heights from January 29 to August 31, 1927.

One of the trees tapped 2 feet, three of the 3-foot, and one of the 4-foot were rested in August due to poor condition.

The girths of the trees tapped at different heights were as follows: 21.12 to 32.44 with an average of 25.5 inches of the 2-foot, 18.62 to 47.62 with an average of 27.24 inches of the 3-foot and 22.56 to 29.62 with an average of 24.8 inches of the 4-foot.

The monthly yields in dry rubber of each of the experiments were recorded separately till July 15 when by mistake the latex of the three conditions after it had been measured was mixed and coagulated together so that the yields and the percentage of dry rubber for the months of July and August were calculated from the total dry rubber produced.

The trees tapped 2 feet high gave the highest yield both in latex and dry rubber during the seven months' tapping, then the 4-foot trees second, and the 3-foot trees last. The corresponding yields of each were 43.447 liters latex and 15.165 kilos dry rubber of the 2-foot trees, 39.813 liters latex and 15.082 kilos dry rubber of the 4-foot trees, and 22.958 liters latex and 9.993 kilos dry rubber of the 3-foot trees. The trees tapped 3 feet high yielded 40.40 per cent rubber content during the five months' tapping as compared with only 31.04 per cent and 35.33 per cent for the trees tapped 2 feet and 4 feet, respectively.

The relative merits of the best yielding trees tapped differently at the Halcon Rubber Sub-station, Baco, Mindoro, are given below:

Tapping intervals

[From May 31, 1926 to August 31, 1927]

Daily			Alternate daily			Alternate week		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
161	44.3	7.663	3	37.3	2.890	43	44.7	2.176
168	34.5	6.791	16	28.6	2.062	49	35.8	2.153
170	37.1	6.021	17	41.8	2.232	50	29.4	2.391
173	45.1	8.418	20	30.2	3.356	51	29.8	3.134
174	28.3	5.218	23	39.3	4.304			
175	39.8	6.459	25	35.6	2.064			
177	48.1	13.009	26	40.1	2.345			
179	39.7	5.299						
181	51.6	6.986						
187	60.5	5.462						

Tapping intervals—Continued

[From May 31, 1926 to August 31, 1927]

Alternate two-weeks			Alternate three-weeks			Alternate monthly		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
84	54.8	2.126	100	24.5	1.118	137	54.5	5.054
86	35.7	4.011	108	26.6	1.281	138	36.5	2.340
87	47.1	5.275	109	24.5	1.120	144	39.3	4.300
88	29.3	3.444	122	23.0	1.357	148	33.5	3.436
89	24.5	2.024				151	41.5	2.957
91	28.5	2.584				152	48.0	3.357
						155	57.5	2.866
						157	50.5	3.784

[From October 29, 1926 to August 31, 1927]

Two-day intervals			Three-day intervals			Four-day intervals		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
200	27.8	1.646	228	38.0	1.489	244	57.3	1.879
201	25.2	1.766	232	41.0	1.756	246	30.8	2.077
205	25.7	1.628	240	29.2	1.988	247	24.1	1.802
213	26.8	1.868	241	33.5	2.632	252	29.5	2.313
						260	24.3	1.953
						265	25.1	2.129

Five-day intervals			Six-day intervals			Six-month intervals		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
274	45.0	4.162	293	26.5	1.033	315	27.8	2.119
282	41.6	5.210	307	25.2	1.018	320	36.4	2.524
285	34.3	3.381	309	35.2	2.126	321	34.7	1.880

Tapping system

Half-spiral[a]					
Daily			Alternate day		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*
1	34.5	3.728	53	38.8	2.966
2	36.6	4.248	57	31.3	3.707
13	31.5	4.371	60	44.5	6.112
17	42.5	5.050	65	33.1	3.898
21	42.9	3.897	66	37.2	3.023
23	33.6	4.899	67	40.0	3.566
26	37.8	5.453	69	50.3	3.899
31	25.9	4.320	78	45.8	2.921
38	28.5	4.249	80	42.5	4.784
44	40.3	5.329	81	38.5	2.671

[3] Tapped from July 1926 to August 1927.

Tapping system—Continued

V-shape[a]						Opposite V's[b]		
Daily			Alternate day			Daily		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
90	40.6	8.584	138	39.1	3.213	185	37.6	5.503
93	41.1	3.666	139	31.6	2.701	188	40.3	3.185
96	30.4	4.950	148	35.8	2.814	192	37.5	3.157
110	36.5	4.819	181	34.1	2.199	195	31.7	3.628
122	41.7	3.596				207	31.5	4.112
126	51.7	4.476				214	31.3	2.215
128	41.6	3.664				215	27.1	2.542
130	26.3	4.744				216	41.3	2.980
131	49.9	4.437				221	29.2	2.701
132	42.5	7.052				222	30.7	2.407

[a] Tapped from July 1926 to August 1927.
[b] Tapped from January to August 1927.

Tapping once and twice a day

Twice a day (a. m. and p. m.)[a]						Once a day (p. m.)[b]					
Daily			Alternate daily			Daily			Alternate daily		
Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber	Tree number	Girth	Dry rubber
	Inches	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*		*Inches*	*Kilos*
5	35.9	3.358	41	37.2	4.703	7	48.1	6.863	71	31.2	5.954
9	36.6	5.948	50	22.5	3.133	11	36.1	6.228	76	27.3	3.582
10	34.6	4.021	51	39.8	5.420	25	44.8	5.059	82	26.2	3.464
13	40.1	4.548	59	29.1	4.817	35	44.7	4.655	91	44.7	3.499
15	30.4	4.337				37	38.1	7.286	103	40.4	3.770
19	31.1	4.005				39	27.8	4.599	111		3.771
22	37.0	5.489				41	38.1	4.833	118		3.425
24	44.5	3.024				45	32.5	4.874	123		3.002
						49	39.1	5.429	124		5.679
						61	36.8	5.844			

[a] Tapped from October 27, 1926 to August 31, 1927.
[b] Tapped from July 1, 1926 to August 22, 1927.

The three highest yielding trees are as follows:

Tapping intervals:

Trees No. 161, 173, and 177 of the trees tapped daily
Trees No. 3, 20, and 23 of the trees tapped alternate days
Trees No. 43, 50, and 51 of the trees tapped alternate weeks
Trees No. 86, 87, and 88 of the trees tapped alternate two weeks
Trees No. 108, 109, and 122 of the trees tapped three weeks alternate
Trees No. 137, 144, and 148 of the trees tapped alternate months
Trees No. 200, 201, and 213 of the trees tapped daily at two days' interval
Trees No. 232, 240, and 241 of the trees tapped daily at three days' interval
Tres No. 246, 252, and 265 of the trees tapped daily at four days' interval
Trees No. 274, 282, and 285 of the trees tapped daily at five days' interval

Tapping intervals—Continued.

Trees No. 293, 307, and 309 of the trees tapped daily at six days' interval

Trees No. 315, 320, and 321 of the trees tapped daily at six months' interval

Tapping systems:

Trees No. 17, 26, and 44 of the trees tapped daily in half-spiral cut

Trees No. 60, 69, and 80 of the trees tapped alternate days in half-spiral cut

Trees No. 90, 96, and 132 of the trees tapped daily in V-shaped cut

Trees No. 138, 139, and 148 of the trees tapped alternate days in V-shaped cut

Trees No. 185, 195, and 207 of the trees tapped daily in opposite V's cuts

Tapping once and twice a day:

Trees No. 9, 13, and 22 of the trees tapped daily and twice a day

Trees No. 41, 51, and 59 of the trees tapped alternate days and twice a day

Trees No. 7, 11, and 37 of the trees tapped daily in the afternoon

Trees No. 71, 111, and 124 of the trees tapped alternate days in the afternoon

Deducing the possible yearly yields per tree of the trees tapped differently if tappings have been done during the whole period without any interruptions whatsoever, because of unfavorable weather conditions, plant diseases, absences of the tappers, etc., the following yields might be expected from the trees yearly:

Tapping intervals

	Tapping days	Yield per tree
		Kilos
Daily	365	3.929
Alternate days	182	1.406
Every two days	182	1.192
Every three days	183	1.201
Every four days	184	1.577
Every five days	185	1.681
Every six days	185	0.831
Weekly alternate	182	1.039
Two weeks alternate	91	0.618
Three weeks alternate	63	0.182
Alternate months	182	1.465
Alternate six months	182	1.182

Tapping systems

Half-spiral daily	365	2.752
Half-spiral alternate days	182	2.208
V-shape daily	365	2.673
V-shape alternate days	182	1.338
Opposite V's daily	365	2.888

Tapping once and twice a day

	Tapping days	Yield per tree
		Kilos
Once a day in the morning daily	365	2.752
Once a day in the morning alternate days	182	2.208
Once a day in the afternoon daily	365	3.248
Once a day in the afternoon alternate days	182	2.084
Twice a day morning and afternoon daily	730	3.529
Twice a day morning and afternoon alternate days	364	2.294

Tapping heights

Two-feet daily	365	2.049
Three-feet daily	365	1.351
Four-feet daily	365	2.038

PROGRESS REPORT ON THE STORAGE AND CURING OF MANDARIN ORANGES AT THE TANAUAN CITRUS EXPERIMENT STATION

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The Tanauan Citrus Experiment Station started, in 1920, a series of experiments on the storage and curing of the Batangas mandarin orange. The objects were to find a means of storing the fruit so as to lengthen the period of time in which it may be marketed, and also to improve the color and quality of the fruit. It was deemed important, moreover, that such a means should be convenient and cheap enough for the growers in the citrus district to practice.

It was determined in 1920 that it was possible to store the fruit in an underground storage chamber for a longer period of time than was usually thought possible. These preliminary investigations showed that the fruit could be made to assume a uniform orange color and in addition its general quality considerably improved. The curing of the oranges was entirely accomplished fourteen to twenty days after placing them in the vault. These experiments, however, showed that twenty days was the limit of time that it was economically possible to store the fruit. After that period the loss was so great that storing would not be economically feasible using the methods employed.

Data were also obtained in these first experiments which showed that there was a larger loss in clipped fruits than in those picked by the ordinary way; that a slightly larger loss was found in the green than in the ripe fruit; and that the size of fruit did not make any difference in its keeping quality.

All these results were obtained with fruits that were not treated with any disinfecting solutions. The unventilated, underground storage chamber which was used was described in the account of the experiments which was published in the Philippine Agricultural Review, Vol. 13, pages 214–217, 1920.

Year 1923.—In 1923 the storing was done in an underground chamber made very much like the one previously used except that it was provided with a chimney, one foot in diameter, so that a slow current of air passing through the chamber resulted. A tight door was also provided to exclude the entrance of warm drafts during the daytime. During the night this door was kept open.

The fruits used in the experiments were all harvested during the month of January, and were in about the same stage of maturity. Two methods were used in picking the fruit—one was by clipper, so as to leave a short portion of the stem on the fruit, and the other one was by the ordinary Batangas method, i.e., by pulling and twisting the fruit, leaving no portion of the stem.

The fruits were separated into lots treated as follows: (1) check, not disinfected; (2) immersed in 0.2 per cent solution of formalin, some lots for 3 minutes and others for 5 minutes; (3) immersed in 0.018 per cent solution of copper sulphate, some lots for 3 minutes and others for 5 minutes; and (4) immersed for 5 minutes in potassium permanganate solutions of 0.018, 0.025, and 0.05 per cent concentrations. Each lot of fruits was placed in storage two days after picking, and the different lots were similarly exposed to the open air, previous to storing them in the chamber.

Table I bears a general summary of the results obtained in these experiments. Of the 1,587 fruits used, the check lots had 419 fruits, the lots disinfected with formalin, 419, the lots disinfected with copper sulphate solution, 419, and the lots disinfected with potassium permanganate solution, 33 fruits.

These results indicate that there was distinctly less decay of fruit in the lots treated with permanganate solution than in the others. After six weeks of storage, the average loss of fruit in the lots disinfected with potassium permanganate was 25.8 per cent, in those of the check, 32.7 per cent, in the formalin lots, 33.1 per cent and in the copper sulphate lots, 34.8 per cent. After eleven weeks of storage, the lots disinfected with potassium permanganate showed an average loss of 73.9 per cent, the formalin lots, 79.5 per cent, the check lots, 80.0 per cent, the copper sulphate lots, 82.3 per cent. The marked superiority shown by the potassium permanganate over the other disinfectants cannot be accounted for, unless it is that it might be more effective in killing the organism causing most of the decay, or, that the concentrations of the formalin and copper sulphate solutions used were too weak to be effective.

TABLE I.—*Showing the percentage of decay in fruits of the Batangas mandarin orange, treated with various disinfectants, and cured and stored in an underground, ventilated chamber*

Treatment of fruit	Kind of fruit	Date placed in storage	Number	Fruit decayed							
				First week		Second week		Third week		Fourth week	
				Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Check:											
No treatment	Clipped, stem on	Jan 6, 1923	66	0	0	0	0	2	3.0	7	10.6
Do	do	Jan 13, 1923	80	1	1.3	1	1.3	5	6.3	11	13.8
Do	Picked, no stem	do	123	2	1.6	4	3.3	4	3.3	16	13.0
Do	do	Jan 20, 1923	150	0	0	9	6.0	21	14.0	27	18.0
Totals			419	3	0.7	14	3.3	32	7.6	61	14.6
Formalin solution:											
0.2 per cent, 3 minutes	Clipped, stem on	Jan 6, 1923	66	0	0	1	1.5	7	10.6	13	19.7
Do	do	Jan 13, 1923	80	0	0	1	1.3	2	2.5	4	5.0
Do	Picked, no stem	do	123	0	0	0	0	2	1.6	7	5.7
0.2 per cent, 5 minutes	do	Jan 20, 1923	150	0	0	4	2.7	14	9.3	22	14.7
Totals			419	0	0	6	1.4	27	6.4	46	11.0
Copper sulphate solution:											
0.018 per cent, 3 minutes	Clipped, stem on	Jan 6, 1923	66	1	1.5	1	1.5	7	10.6	15	22.7
Do	do	Jan 13, 1923	80	3	3.8	5	6.3	7	8.8	10	12.5
Do	Picked, no stem	do	123	0	0	0	0	1	0.8	5	4.1
0.018 per cent, 5 minutes	do	Jan 20, 1923	150	1	0.7	9	6.0	21	14.0	30	20.0
Totals			419	5	1.2	15	3.6	36	8.6	60	14.3
Potassium permanganate solution:											
0.025 per cent, 5 minutes	Clipped, stem on	Jan 13, 1923	90	0	0	0	0	0	0	3	3.3
0.05 per cent, 5 minutes	do	do	90	0	0	1	1.1	4	4.4	8	8.9
0.018 per cent, 5 minutes	Picked, no stem	Jan 20, 1923	150	1	0.7	5	3.3	12	8.0	23	15.3
Totals			330	1	0.3	6	1.8	16	4.8	34	10.3

TABLE I.—*Showing the percentage of decay in fruits of the Batangas mandarin orange, treated with various disinfectants, and cured and stored in an underground, ventilated chamber*—Continued

Treatment of fruit	Fruit decayed													
	Fifth week		Sixth week		Seventh week		Eighth week		Ninth week		Tenth week		Eleventh week	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Check:														
No treatment	28	42.4	44	66.7	48	72.7	54	81.8	59	89.4	62	93.9	63	95.5
Do	15	18.8	25	31.3	37	46.8	47	58.8	52	65.0	57	71.3	65	81.3
Do	20	16.3	29	23.6	39	31.7	53	43.1	68	55.3	86	69.9	93	75.6
Do	29	19.3	39	26.0	53	35.3	76	50.7	88	58.7	99	66.0	114	76.0
Totals	92	22.0	137	32.7	177	42.2	230	54.9	267	63.7	304	72.6	335	80.0
Formalin solution:														
0.2 per cent, 3 minutes	26	39.4	37	56.1	53	80.3	58	87.9	62	93.9	65	98.5	66	100.00
Do	11	13.8	24	30.0	40	50.0	48	60.0	56	70.0	60	75.0	63	78.8
Do	14	11.4	27	22.0	55	44.7	81	65.9	97	78.9	110	89.4	111	90.2
0.2 per cent, 5 minutes	30	20.0	51	34.0	61	40.7	71	47.3	82	54.7	87	58.0	93	62.0
Totals	81	19.4	139	33.1	209	49.9	258	61.6	297	70.9	322	76.9	333	79.5
Copper sulphate solution:														
0.018 per cent, 3 minutes	37	56.1	48	72.7	53	80.3	61	92.4	63	95.5	63	95.5	63	95.5
Do	14	17.5	20	25.0	35	43.8	47	58.8	57	71.3	63	78.8	69	86.3
Do	13	10.6	29	23.6	54	43.9	73	59.4	82	66.7	105	85.4	113	91.9
0.018 per cent, 5 minutes	37	24.7	48	32.0	61	40.7	73	48.7	80	53.3	95	63.3	100	66.7
Totals	101	24.1	146	34.8	203	48.5	254	60.6	282	67.3	326	77.8	345	82.3
Potassium permanganate solution:														
0.025 per cent, 5 minutes	15	16.7	30	33.3	43	47.8	58	64.4	64	71.1	77	85.6	80	88.9
0.05 per cent, 5 minutes	14	15.6	22	24.4	26	28.9	39	43.3	49	54.4	66	73.3	69	76.7
0.018 per cent, 5 minutes	29	19.3	33	22.0	47	31.3	65	43.3	79	52.7	89	59.3	95	63.3
Totals	58	17.6	85	25.8	116	35.2	162	49.1	192	58.2	232	70.3	244	73.9

After several weeks of storage, sound fruits under the same conditions and treatments exhibited varying qualities—some having improved greatly in flavor and eating quality, while others not; some remained juicy, while others became dry; and in some the skin assumed a silky and pliable condition, while in others it remained firm and rather brittle. It should be remarked that the fruits used in the experiments were obtained from seedling trees, and it is probable that this lack of uniformity was due to the variability inherent in the fruits of such trees.

Table II presents a comparison of the extent of decay in fruits picked in the ordinary way and in those harvested with a clipper. The figures show that at the end of the sixth and eleventh weeks, the average percentages of loss were 26.4 and 74.2 respectively, in the picked fruits, and 45.2 and 88.8 respectively, in the clipped fruits. These results agree with those already obtained in the previous experiments.

TABLE II.—*Showing the extent of decay in Batangas mandarin oranges picked by the ordinary way and by clipping.*

	Total No.	Fruits decayed—			
		Sixth week		Eleventh week	
Clipped		Number	Per cent	Number	Per cent
Not disinfected	80	25	31.3	65	81.3
Disinfected with formalin	80	24	30.0	63	78.8
Disinfected with copper sulphate	80	20	25.0	69	86.3
Not disinfected	66	44	66.7	63	95.5
Disinfected with formalin	66	37	56.1	66	100.0
Disinfected with copper sulphate	66	48	72.7	63	95.5
Averages	438	198	45.2	389	88.8
PICKED ORDINARY WAY					
Not disinfected	123	29	23.6	93	75.6
Disinfected with formalin	123	27	22.0	111	90.2
Disinfected with copper sulphate	123	29	23.6	113	91.9
Not disinfected	150	39	26.0	114	76.0
Disinfected with formalin	150	51	34.0	93	62.0
Disinfected with copper sulphate	150	48	32.0	100	66.7
Disinfected with potassium permanganate	150	33	22.0	95	63.3
Averages	969	256	26.4	719	74.2

A possible explanation for this fact is as follows: An examination of the decayed fruits revealed the fact that about 81 per cent of the loss was due to a decay which proceeded from the stem ends of the fruits. The organism causing the decay was probably located in the stem end region of the fruits and already present in a dormant state at the time of picking. When the stem is entirely removed from the fruit, as in the case when it is plucked off, the tissues in which the organism is lodged become hardened on exposure to the air, thus retarding or

entirely preventing the development of the organism. The tendency is for this organism to develop as the fruit becomes weaker and it is probable that this tendency is greater in clipped fruit having a portion of the stem attached than in fruit with the stem entirely removed. However, a further study is necessary before final statements can be made on this point.

The results obtained, thus far, in this work may be summarized as follows:

(1) That the ventilated type of underground storage chamber has given much better results than the unventilated type, in the storage and curing of mandarin oranges.

(2) That, under the conditions in which they were grown, fruits picked in the ordinary Batangas method kept better than clipped fruits.

(3) That disinfection of the fruit by immersing it for 5 minutes in 0.018 per cent solution of potassium permanganate before placing it in storage has markedly improved its keeping quality.

(4) That it is practicable to store mandarin oranges at least six weeks by using the ventilated type of storage chamber, at the same time greatly improving the appearance and eating quality of the fruit. However, it is believed that this period of time is not the limit of successful storage because many of the fruits remained in good condition even after the eleventh week of storage.

Year 1924.—In the previous experiments, the chambers used were constructed with earthen walls. In the present experiment a ventilated chamber with cement walls and ceiling was used. This chamber was constructed at a cost of about ₱350 and is capable of containing 6,000 oranges.

The fruits used were partly obtained from the Station orchard and partly from Balele, a distant barrio. They were picked carefully from the trees, in the ordinary way. The fruits from Balele were transported on horseback, over 10 kilometers of rough road, and they were considerably damaged.

The fruits were separated into three lots: Lot 1. Immersed for 5 minutes in 0.2 per cent formalin solution. Lot 2. Immersed for 5 minutes in 0.018 per cent potassium permanganate solution. Lot 3. Check, no treatment. Weekly observations were made until the 10th week. Some of the fruits in all of

these lots were kept in storage until the 14th week, when counts of decayed fruit were again made.

Discussion of Results.—Table III, gives a summary of the percentages of decayed fruits in these observations of the different lots. The Station fruits gave much better results than the Balele fruits which were injured while in transit. The percentage of decay in the Balele lots was about double that of the Station lots of fruits. After six weeks of storage, the Station fruit lost, through decay, 32.9 per cent in the formalin treated lot; 22.5 per cent in the potassium permanganate treated lot; and 22.7 per cent in the check lot. After the 10th week of storage, the loss of Station fruit was 82.4 per cent in the formalin treated lot; 74.1 per cent in the potassium permanganate treated lot; and 70.5 per cent in the check lot, while, after the 14th week of storage, the corresponding losses were 92.6 per cent, 83.5 per cent, and 83.1 per cent.

These percentages are averages of Station fruits picked January 7 and January 14, 1924. There is shown in these results a marked superiority in the keeping quality of the fruits picked later, and this is explainable only by the more careful picking and handling of the former. The results of this experiment confirm those of the previous experiments that formalin is a poor disinfectant for stored mandarin oranges. However, unlike the results of the previous experiment, the fruit disinfected with potassium permanganate did not show any superiority in its keeping quality over the untreated fruit.

Observations of the fruit in the course of the experiment showed that the orange color of the rind developed during the second week of storage. The eating quality of the fruit improved in the first few weeks and kept good until about the eighth week of storage when the fruit became drier and drier until too dry for eating.

Conclusions.—Better results were obtained in the storage of Batangas mandarin oranges with the use of the present cement underground chamber than with the former earthen chambers. The smallest per cent of decayed fruit, after six weeks of storage, was 22.5 per cent in the cement, and 25.8 per cent in the former earthen chamber, both in the potassium permanganate treated lots.

TABLE III.—*Weekly percentages of decay in fruits of the Batangas mandarin orange treated and untreated with disinfectants and placed in the cement underground chamber at Tanauan Citrus Station.*

Treatment of fruit	Origin and size of fruit	Date placed in storage	Number	Fruit decayed—							
				First week		Second week		Third week		Fourth week	
				Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Immersed for 5 minutes in 0.2 per cent formalin solution	Station 3 inches size	Jan 7, 1924	50	0	0	0	0	2	4.0	4	8.0
	Station 2¾ inches size	do	350	1	0.3	3	0.9	9	2.6	20	5.7
	do	Jan. 14, 1924	110	0	0	0	0	0	0	0	0
	Station 2½ inches size	do	80	0	0	0	0	0	0	1	1.3
Totals			590	1	0.2	3	0.5	11	1.9	25	4.2
	Balele 3 inches size	Jan. 7, 1924	103	0	0	2	1.9	14	13.6	15	14.6
	Balele 2¾ inches size	do	315	6	1.9	45	14.3	75	23.8	118	37.5
Totals			418	6	1.4	47	11.3	89	21.3	133	31.8
Immersed for 5 minutes in 0.02 per cent potassium permanganate solution	Station 3 inches size	Jan. 7, 1924	50	1	2.0	1	2.0	1	2.0	1	2.0
	Station 2¾ inches size	do	350	0	0	4	1.1	8	2.2	19	5.4
	do	Jan. 14, 1924	110	0	0	0	0	0	0	1	0.9
	Station 2½ inches size	do	80	0	0	1	1.3	1	1.3	1	1.3
Totals			590	1	0.2	6	1.2	10	1.7	22	3.7
	Balele 3 inches size	Jan. 7, 1924	103	0	0	11	10.6	24	23.3	37	35.9
	Balele 2¾ inches size	do	315	0	0	21	6.7	68	21.6	85	26.9
Totals			418	0	0	32	7.7	92	22.1	122	29.2
Check, the fruits were untreated	Station 3 inches size	Jan. 7, 1924	50	0	0	0	0	0	0	2	4.0
	Station 2¾ inches size	do	350	1	0.3	8	2.2	16	4.6	26	7.4
	do	Jan. 14, 1924	110	0	0	1	0.9	1	0.9	1	0.9
	Station 2½ inches size	do	80	0	0	1	1.3	1	1.3	1	1.3
Totals			590	1	0.2	10	1.7	18	3.1	30	5.1
	Balele 3 inches size	Jan. 7, 1924	103	3	2.9	14	13.6	25	24.3	37	35.9
	Balele 2¾ inches size	do	315	2	0.6	33	10.5	60	19.0	82	26.3
Totals			418	5	1.2	47	11.2	85	20.3	119	28.4

Treatment of fruit	Fruit decayed—													
	Fifth week		Sixth week		Seventh week		Eighth week		Ninth week		Tenth week		Eleventh week	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Immersed for 5 minutes in 0.2 per cent formalin solution	8	16.0	13	26.0	27	54.0	32	62.0	41	82.0	41	82.0	[a]	[a]
	88	25.1	145	41.4	240	68.6	269	76.9	307	87.7	318	90.9	338	96.6
	4	3.6	22	20.0	32	29.1	52	47.3	68	61.8	71	64.5	89	80.9
	3	3.8	14	17.5	23	28.8	39	48.8	50	62.5	56	70.0	73	91.3
Totals	103	17.5	194	32.9	322	54.6	392	66.4	466	79.0	486	82.4	500	92.6
	37	35.9	60	58.3	82	79.6	91	88.3	98	95.1	101	98.1	[a]	[a]
	160	50.8	212	67.3	229	72.7	238	75.6	246	78.1	252	80.0	263	83.5
Totals	197	42.1	272	65.1	311	74.4	329	78.7	344	82.3	353	84.4	263	83.5
Immersed for 5 minutes in 0.02 per cent potassium permanganate solution	10	20.0	14	28.0	29	58.0	33	66.0	40	80.0	41	82.0	[a]	[a]
	45	12.9	95	27.1	167	47.7	187	53.4	249	71.1	273	78.0	317	90.6
	3	2.7	13	11.8	23	20.9	41	37.3	58	52.7	65	59.1	85	77.3
	1	1.3	11	13.8	13	16.3	36	45.0	48	60.0	58	72.5	70	87.5
Totals	59	10.0	133	22.5	232	39.3	297	50.3	395	66.9	437	74.1	472	87.4
	44	42.7	54	52.4	70	68.0	77	74.8	89	86.4	98	95.1	[a]	[a]
	128	40.6	188	59.7	227	72.1	242	76.8	258	81.9	282	89.5	298	94.6
Totals	172	41.1	242	57.8	297	71.1	319	76.3	347	83.0	380	90.9	298	94.6
Check the fruits were untreated	6	12.0	14	28.0	32	64.0	33	66.0	39	78.0	42	84.0	[a]	[a]
	46	13.1	98	28.0	186	53.1	211	60.3	254	72.6	278	79.3	306	87.4
	3	2.7	10	9.1	15	13.6	31	28.3	46	41.8	52	47.3	76	69.1
	2	2.5	12	15.0	17	21.3	26	32.5	34	42.5	44	55.0	67	83.7
Totals	57	9.5	134	22.7	250	42.4	301	51.0	373	63.2	416	70.5	449	83.1
	45	43.7	58	56.3	71	68.9	77	74.8	92	89.3	98	95.1	[a]	[a]
	127	40.8	166	52.7	213	67.6	234	74.3	251	79.7	262	83.1	283	89.8
Totals	172	41.1	224	53.6	284	67.9	311	74.4	343	82.0	360	86.1	283	89.8

[a] Discontinued.

Fruits carefully picked and handled gave lower percentages of decayed fruit than the foregoing figures. The check lot and the potassium permanganate treated lot, each containing 190 fruits, placed in storage on January 14, 1924, gave average losses of 16.8 per cent and 18.4 per cent respectively, after seven weeks of storage. On the other hand, fruits carefully handled, but packed in baskets and transported on horseback over rough roads, gave very poor storage results.

Year 1925.—In 1925, the objects of the experiment were: (*a*) to compare the storing qualities of untreated fruit with those of similar fruit immersed for 5 minutes in a 0.018 per cent potassium permanganate solution; (*b*) to determine the keeping qualities of "weak" fruit as compared with the normal fruit. "Weak" fruits are those produced by trees, which through exhaustion or other causes, are devitalized. Such fruits are easily detached from their stems, unlike the normal ones, which cling quite tightly to their stems, even though ripe.

The fruits used in the experiment were selected, and all of them were kept in the underground storage chamber of the station.

Table IV shows the loss of fruit, from the three lots of fruit, due to decay of all sorts, during the ten weeks of storage.

TABLE IV.—*Showing percentages of decayed fruits under different treatments*

Kind and treatment of fruit	Fruit decayed—					
	Number of fruits stored	Date placed in storage	First week		Second week	
			Number	Per cent	Number	Per cent
I. Normal fruit disinfected with 0.018 per cent potassium permanganate solution.	516	Jan. 17, 1925	0	0	1	0.2
	347	Jan. 24, 1925	1	0.3	3	0.9
	369	Jan. 31, 1925	1	0.3	7	1.9
	573	Jan. 10, 1925	0	0	1	0.2
Totals	1,805		2	0.1	12	.07
II. Normal fruit not treated	508	Jan. 17, 1925	0	0	6	1.2
	347	Jan. 24, 1925	0	0	1	0.3
	370	Jan. 31, 1925	0	0	2	0.5
	573	Jan. 10, 1925	0	0	10	1.7
Totals	1,798		0	0	19	1.1
III. Same as II but has no corresponding disinfected lot	540	Feb. 7, 1925	3	0.5	6	1.1
"Weak" fruit, disinfected with 0.018 per cent potassium permanganate solution.	43	Jan. 10, 1925	0	0	4	9.3
	21	Jan. 24, 1925	0	0	5	23.8
Totals	64		0	0	9	14.1

TABLE IV.—*Showing percentages of decayed fruits under different treatments*—Continued

Kind and treatment of fruit	Fruit decayed—							
	Third week		Fourth week		Fifth week		Sixth week	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
I. Normal fruit disinfected with 0.018 per cent potassium permanganate solution.	9	1.7	61	11.8	88	17.1	231	44.8
	19	5.5	34	9.8	65	18.7	111	32.0
	12	3.3	12	3.3	23	6.2	54	14.6
	8	1.4	62	18.2	187	32.6	263	45.9
Totals.....	48	2.7	169	9.3	363	20.1	659	36.5
II. Normal fruit not treated.	26	5.1	74	14.6	118	23.2	227	44.7
	11	3.2	32	9.2	60	17.3	109	31.4
	6	1.6	17	4.6	38	10.3	80	21.6
	25	4.4	66	11.5	153	26.7	206	36.0
Totals.....	68	3.8	189	10.5	369	20.5	622	34.6
Same as II but has no corresponding disinfected lot.	12	2.2	20	3.7	60	11.1	95	17.6
III. "Weak" fruit, disinfected with 0.018 per cent potassium permanganate solution.	5	11.6	19	44.2	24	55.8	32	74.4
	6	28.6	7	33.3	12	57.1	13	61.9
Totals.....	11	17.2	26	40.6	36	56.3	45	70.3

Kind and treatment of fruit	Fruit decayed—							
	Seventh week		Eighth week		Ninth week		Tenth week	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
I. Normal fruit disinfected with 0.018 per cent potassium permanganate solution.	284	55.0	358	69.4	408	79.1	438	83.3
	176	50.7	219	63.1	261	78.1	281	81.0
	98	26.6	145	39.3	204	55.3	237	64.2
	364	63.5	410	71.6	464	81.0	485	84.6
Totals.....	922	51.1	1132	62.7	1337	74.1	1441	79.8
II. Normal fruit not treated.	286	56.3	357	70.3	393	77.4	421	82.9
	169	48.7	197	56.7	234	67.4	253	72.9
	133	35.9	181	48.9	226	61.1	257	69.5
	300	52.4	341	59.5	395	68.9	426	74.3
Totals.....	888	49.4	1076	59.8	1248	69.4	1357	75.5
Same as II but has no corresponding disinfected lot.	130	24.1	198	36.7	253	46.9	307	56.9
III. "Weak" fruit, disinfected with 0.018 per cent potassium permanganate solution.	36	83.7	37	86.0	38	88.4	42	97.7
	13	61.9	17	81.0	20	96.2	20	96.2
Totals.....	49	76.6	54	84.4	58	90.6	62	96.9

Discussion of results.—The results of these storage experiments showed that untreated fruit kept about as well as the fruit disinfected with potassium permanganate, during the first five weeks of storage; and that during the second five weeks of storage, the untreated fruit stored decidedly better than the disinfected fruit.

The "weak" fruit had much poorer keeping qualities than the normal fruit.

In general, the results of the storage of mandarin oranges this year were not so good as in previous years. This was probably due to the presence of stem end rot among the stored fruits.

There were only two lots of fruit which kept very well during the storage experiment. In Group I, the lot stored on January 31, 1925, showed percentage losses, after the fifth and successive weeks of storage, of only, 6.2, 14.6, 26.6, 39.3, 55.3, and 64.2. An untreated lot, Group II, stored on February 7, 1925, showed percentage losses, after the fifth and successive weeks of storage, of only 11.1, 17.6, 24.1, 36.7, 46.9, and 56.9.

COVER CROP, FERTILIZER, AND TOP-WORKING EXPERIMENTS WITH MANDARIN TREES AT THE TANAUAN CITRUS EXPERIMENT STATION FROM 1923 to 1927

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CONTINUOUS COVER CROP VS. TILLAGE-COVER CROP FOR BATANGAS MANDARIN TREES

One of the most important experiments which has been carried on since 1923 has been to determine which cultural practice would best suit the Batangas mandarin orchard.

Table 1 shows the average yields of trees, annually, and for the five-year period 1923–1927, in plots under different cultural treatments and cover crops. The average health conditions of the trees are also shown in this table, expressed numerically as follows: 1 stands for very poor, 2 for poor, 3 for fair, 4 for good, and 5 for very good condition.

Year	*Tephrosia*— no tillage Block A, average of 23 trees		Tillage— cover crop Block A, average of 18 trees		Cacahuate— no tillage Block A, average of 22 trees		Patani— no tillage Block B, average of 37 trees		Tillage— cover crop Block B, average of 114 trees		Cacahuate— no tillage Block B, average of 47 trees	
	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition
1923	0	3	0	3	0	3	20.2	3	21.1	3	55.4	3
1924	11.0	3.4	6.6	2.9	10.1	3.1	31.8	4.4	29.7	3.5	45.0	3.8
1925	7.8	4.5	5.4	2.6	0.8	2.8	17.1	4.1	6.8	2.9	12.1	4.4
1926	75.0	4.1	12.9	2.1	20.9	2.7	59.5	3.8	40.2	3.5	351.8	4.5
1927	237.0	4.9	33.1	3.3	77.0	3.8	58.8	4.0	30.5	3.9	94.3	4.8
Average of 5 years	66.2	4.0	11.6	2.8	21.8	3.1	37.5	3.9	25.7	3.4	111.8	4.1

Discussion of results.—It is shown in the foregoing table that in Block A, with a poor soil at the start of the experiment, the trees with continuous cover crops of *Tephrosia* and cacahuate, were better off, both in yields and condition, than those under tillage and temporary cover crops. Of the two legumes used

for continuous cover cropping in this block, the *Tephrosia* benefited the trees more than the cacahuate did.

In Block B, with a fairly good soil at the start of the experiment, continuous cover cropping with legumes again proved more beneficial to the trees than did tillage and temporary cover cropping. The continuous cover crop of cacahuate proved to be better than the patani.

THE EFFECT OF CONTINUOUS LEGUMINOUS COVER CROPS ON THE NITROGEN CONTENT OF BATANGAS MANDARIN ORCHARD SOILS

That the soil is greatly benefited by growing on it continuous leguminous cover crops has been evident from the favorable response which mandarin trees have shown when such cover crops are present. Chemical analyses of Batangas mandarin soils in this station, previous to and after planting cover crops, have shown tremendous increases in the nitrogen content of the soil due to the use of the legumes.

Before planting the leguminous cover crops, in February 1923, soil samples from different plots were submitted for chemical analysis at the Bureau of Science. In September 1927, soil samples from the same plots, after having had the cover crops for from 1.5 to 4 years, were again submitted for analysis. The precaution was taken not to get the latter samples where commercial fertilizers might have affected their composition.

Table 2 gives the percentages of nitrogen in these soils, previous to and after having the cover crops. This table also shows the computed increases in the quantities of nitrogen, which may be ascribed to the enriching effect of the legumes. In this computation, it was supposed that about 6.5 inches of the surface soil was affected, and the weight of this soil is estimated at 2,000,000 kilos per hectare.

Discussion of results.—The table shows the tremendous soil enriching properties of leguminous cover crops. From 420 to 1,480 kilos of nitrogen per hectare have been added. Without any other advantage than that of adding nitrogen to the soil a hectare of leguminous cover crop would become worth from ₱252 to ₱888 to the soil, in from 1.5 to 4 years, by adding from 420 to 1,480 kilos of nitrogen, valued at ₱0.60 a kilo. The value of a cover crop, however, is not only due to its ability to add nitrogen to the soil. It also furnishes humus, which benefits the soil in many important ways.

TABLE 2.—*Nitrogen content of Batangas mandarin orchard soils previous to and after having had continuous leguminous cover crops*

Plot and kind of cover crop	Duration experiment	N content previous to cover cropping	N content after having had cover crop	Increase in N content	Computed quantity of N added per hectare
	Years	*Per cent*	*Per cent*	*Per cent*	*Kilos*
Block A. *Tephrosia candida*	4	0.058	0.129	0.071	1,420
Block A. Cacahuate	3	0.074	0.148	0.074	1,480
Block B.-east. Patani	4	0.070	0.119	0.049	980
Block B.-east. Cacahuate	4	0.072	0.128	0.056	1,120
Block G. Ipil-ipil	3	0.056	0.107	0.051	1,020
New M. O. Ipil-ipil	3	0.070	0.135	0.065	1,300
New M. O. *Tephrosia*	1.5	0.062	0.128	0.066	1,320
New M. O. *Tephrosia*	3	0.070	0.114	0.044	880
V. C. O. Ipil-ipil	3	0.083	0.104	0.021	420

FERTILIZER EXPERIMENT NO. 8, BLOCK G.

This experiment was started in November 1924. The ground was plowed and prepared, and ipil-ipil was planted for a continuous cover crop. The Batangas mandarin trees were about 19 years old, but were then fast degenerating on account of the incursion of the *Loranthus* parasite, and the insufficient care given them by the former owner of the grove. The soil in this block is alluvial and therefore rich.

Plot 1 (trees No. 1–5). For each tree 0.48 kilo nitrogen, 0.32 kilo phosphoric acid, and 0.24 kilo potash per year, in the form of copra meal, superphosphate and ammonium sulphate.

Plot 2 (trees No. 6–10). For each tree 0.48 kilo nitrogen and 0.32 kilo phosphoric acid per year, in the form of bat guano and nitrate of soda.

Plot 3 (trees No. 11–15). For each tree 0.48 kilo nitrogen and 0.24 kilo potash per year, in the form of ammonium sulphate and H. G. sulphate of potash.

Plot 4 (trees No. 16–20). For each tree 0.23 kilo phosphoric acid and 0.24 kilo potash per year, in the form of superphosphate and H. G. sulphate of potash.

Plot 5 (trees No. 21–25). For each tree 0.48 kilo nitrogen, 0.32 kilo phosphoric acid, and 0.24 kilo potash, plus 0.5 kilo ferrous sulphate, in the form of copra meal, superphosphate, and ammonium sulphate per year.

Plot 6 (trees No. 26–30). Check trees. No fertilizers given.

Plot 7 (trees No. 31–33). For each tree 3 kilos lime and 0.6 kilo sulphur per year.

Plot 8 (trees No. 34–36). For each tree 3 kilos of lime per year.

The progress of this experiment from 1924 to 1927 is shown in Table 3.

TABLE 3.—*Average annual yields and condition of trees in Fertilizer Experiment No. 8*

Plot number and treatment	1924		1925		1926		1927	
	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition	Yield in fruits	Condition
1. N-P-K. Copra meal, superphosphate and ammonium sulphate	40.0	3.4	11.8	2.8	72.0	4.0	395.4	4.4
2. N-P. Bat guano and nitrate of soda	123.4	3.2	20.4	1.4	111.2	3.6	1,043.0	4.6
3. N-K. Ammonium sulphate and H. G. sulphate of potash	114.0	3.4	15.4	2.6	171.6	4.8	903.8	5.0
4. P-K. Superphosphate and H. G. sulphate of potash	125.2	3.6	6.8	1.6	0.6	3.6	566.8	4.8
5. N-P-K-Fe. Copra meal, superphosphate, ammonium sulphate, and ferrous sulphate	85.4	3.6	1.2	4.0	99.4	4.2	413.2	5.0
6. Check trees	17.6	4.0	0	2.0	2.2	3.0	151.8	4.8
7. Lime, sulphur	628.3	3.0	0	2.0	46.3	3.3	413.3	3.7
8. Lime only	224.3	3.0	0.7	2.0	29.3	2.3	4.7	3.7

The lime was applied once in October and the fertilizers twice—in May and November.

Discussion of results.—The progress of this experiment showed the following results:

1. The trees were poor at the beginning of the second year of the experiment probably because of the unfavorable effect of the tillage incident to the planting of the cover crop the previous year. Furthermore, the cover crop and the fertilizers had not had enough time to make their presence felt.

2. The trees receiving nitrogen either in a complete or incomplete mixture generally gave the best yields and were in the best condition in the third and fourth years of the experiment.

3. The supplemental application of ferrous sulphate to a complete fertilizer was of doubtful value.

4. Lime alone was detrimental to the trees.

5. The check trees also improved considerably due probably to the beneficial effect of the cover crop although they were far from improving as rapidly as those receiving nitrogen and other fertilizers.

FERTILIZER AND COVER CROP EXPERIMENT NO. 3

This experiment was begun in 1924. The trees selected for this experiment were quite uniform. They were separated into 8 lots, treated as follows:

1. Trees No. A5, A11, A17. Continuous cover crop of *Tephrosia candida.*

2. Trees No. A6, A12, A16. Same cultural treatment.

3. Trees No. A26, A29, A32, and A40. Tillage and temporary cover crop.

4. Trees No. A30, A33, A50. Same cultural treatment.

5. Trees No. A56, A70, A78. Continuous cover crop of cacahuate.

6. Trees No. A63, A77, A86. Same cultural treatment.

7. Trees No. A1 and A2. Check trees for lots 1 and 2.

8. Tree No. A39. Check tree for lots 3 and 4.

9. Trees No. A72 and A88. Check trees for lots 5 and 6.

All the trees except the check trees were given a complete fertilizer composed of horse manure and superphosphate and containing 0.6 kilo nitrogen, 0.56 kilo phosphoric acid, and 0.48 kilo potash. The trees in lots 1, 3, and 5, received in addition to the above-named fertilizer, 0.9 kilo sulphur. The amounts just stated were for one tree, per year. The fertilizer was given in two applications and the sulphur in only one application per year. Table 4 shows the average annual yields and condition of trees in the different lots in the period from 1924 to 1927.

TABLE 4.—*Average annual yields and condition of trees, 1924–1927. Fertilizer and Cover Crop Experiment No. 3. Block A*

Lot number and cultural treatments	Year	Number of trees	Yield in number of fruits		Health condition	
			Total	Average	Total	Average
1. Continuous cover crop of *Tephrosia candida*	1924	3	40	13.3	10	3.3
	1925	3	14	4.7	15	5.0
	1926	3	307	102.3	14	4.7
	1927	3	517	172.3	15	5.0
2. Continuous cover crop of *Tephrosia candida*	1924	3	5	1.7	10	3.3
	1925	3	56	18.7	14	4.7
	1926	3	407	139.0	13	4.3
	1927	3	959	319.7	14	4.7
3. Tillage and temporary cover crop	1924	4	110	27.5	11	2.8
	1925	4	30	7.5	11	2.8
	1926	4	41	10.3	8	2.0
	1927	4	197	49.3	12	3.0
4. Tillage and temporary cover crop	1924	3	0	0	9	3.0
	1925	3	17	5.7	10	3.3
	1926	3	64	21.3	6	2.0
	1927	3	121	40.3	10	3.3
5. Continuous cover crop of cacahuate	1924	3	32	10.7	12	4.0
	1925	3	26	8.7	12	4.0
	1926	3	640	213.3	14	4.7
	1927	3	531	177.0	14	4.7
6. Continuous cover crop of cacahuate	1924	3	130	43.3	11	3.7
	1925	3	0	0	11	3.7
	1926	3	325	108.3	15	5.0
	1927	3	224	74.7	14	4.7
7. Check trees for lots 1 and 2	1924	2	42	21.0	8	4.0
	1925	2	46	23.0	7	3.5
	1926	2	10	5.0	6	3.0
	1927	2	604	302.0	10	5.0
8. Check trees for lots 3 and 4	1924	1	1	1.0	3	3.0
	1925	1	0	0	2	2.0
	1926	1	0	0	1	1.0
	1927	0	[a]	.....	.....	.....
9. Check trees for lots 5 and 6	1924	2	5	2.5	6	3.0
	1925	2	0	0	5	2.5
	1926	2	50	25.0	4	2.0
	1927	2	89	44.5	8	4.0

[a] Dead.

Discussion of results.—The foregoing table shows the following results:

1. The trees with continuous cover crops continued to improve much faster than those under tillage and temporary cover crops.

2. The unfertilized check lot with *Tephrosia* cover crop made a better average yield in 1927 than any other lot except lot 2, which had *Tephrosia* and a complete fertilizer.

3. Sulphur did no good to the trees to which it was applied.

FERTILIZER, LIME AND COVER CROP EXPERIMENT NO. 7

This experiment was started in January 1925, to determine the value of nitrogen alone, and of complete fertilizers supplemented with lime, on the improvement of Batangas mandarin trees.

The main plan of this experiment can best be understood by examining Table 5 which also shows the yields and condition of the trees in 1927.

Discussion of results—

1. As in 1926, ammonium sulphate again proved to be a much better source of nitrogen than copra meal. The average yield for all the trees receiving ammonium sulphate was 166.0 fruits per tree, while the average yield for all the trees receiving copra meal was only 30.1 fruits per tree. The average health condition for the former trees was 4.7, or almost very good, while that for the latter was only 4.2, or slightly better than good.

2. The largest amount of nitrogen given each tree per year in the ammonium sulphate lots, was 0.5 kilo. The average yields for trees receiving 0.25, 0.5 and 0.75 kilo of nitrogen per tree were 173.6, 259.2 and 65.3 fruits, respectively. In the copra meal lots slightly better yields were produced by the trees receiving 0.75 kilo of nitrogen per tree. The average yields for trees receiving 0.25, 0.5, and 0.75 kilo of nitrogen per tree, were 12.1, 35.1 and 43.1 fruits, respectively.

3. The application of phosphoric acid and potash in addition to ammonium sulphate again slightly increased the yields of trees as compared with those made by trees receiving only ammonium sulphate. In the copra meal lots, however, the additional phosphoric acid and potash slightly lowered the yields.

The results of the experiment for the year 1926 can be seen in Table 6.

TABLE 5.—*Showing the plan of the experiment, the individual and the average yields and health conditions of trees under different fertilizer treatments, 1927*

	2.5 K. lime every 2 years			5.0 K. lime every 2 years			5 K. lime every 2 years + 0.48 K. P_2O_5 + 0.24 K. K_2O			Averages	
	Tree No.	Yield	Condition	Tree No.	Yield	Condition	Tree No.	Yield	Condition	Yield	Condition
0.25 K. N per tree per year in the form of 1.25 K. ammonium sulphate.	A 4	68.0	5	A 19	36.0	5	A 20	463.0	5	173.6	4.9
	B 278	225.0	5	B 277	12.0	5	B 257	51.0	4		
	B 134	281.0	5	B 135	24.0	5	B 157	402.0	5		
Averages		191.3	5		24.0	5		305.3	4.7		
0.5 K. N per tree per year in the form of 2.5 K. ammonium sulphate.	A 21	33.0	5	A 23	341.0	5	A 24	609.0	5	259.2	5.0
	B 282	78.0	5	B 280	10.0	5	B 279	327.0	5		
	B 158	554.0	5	B 212	381.0	5	B 213	0.0	5		
Averages		221.7	5		244.0	5		312.0	5		
0.75 K. N per tree per year in the form of 3.75 K. ammonium sulphate.	A 27	151.0	4	A 28	43.0	5	A 31	23.0	4	65.3	4.4
	B 304	94.0	4	B 303	160.0	5	B 301	30.0	5		
	B 214	28.0	5	B 253	53.0	5	B 293	6.0	3		
Averages		91.0	4.3		85.3	5		19.7	4		
Vertical averages for ammonium sulphate plots		168.0	4.8		117.8	5.0		212.3	4.6		
0.25 K. N per tree per year in the form of 10 K. of copra meal.	A 34	0	4	A 35	4.0	3	A 41	10.0	3	12.1	4.3
	B 247	5.0	5	B 244	2.0	5	B 242	0	5		
	B 68	75.0	4	B 69	0	5	B 93	13.0	5		
Averages		23.3	4.3		2.0	4.3		7.3	4.3		
0.5 K. N per tree per year in the form of 20 K. copra meal	A 42	2	3	A 46	12.0	3	A 47	0	3	35.1	4.1
	B 232	106.0	4	B 227	27.0	5	B 225	48.0	5		
	B 94	14.0	5	B 113	92.0	5	B 115	15.0	4		
Averages		40.7	4		43.7	4.3		21.0	4		
0.75 K. N per tree per year in the form of 30 K. copra meal	A 48	0	3	A 36	0	4	A 37	36.0	4	43.1	4.2
	B 300	112.0	5	B 299	40.0	5	B 298	82.0	5		
	B 116	117.0	5	B 117	1.0	5	B 45	0	2		
Averages		76.3	4.3		13.7	4.7		39.3	3.7		
Vertical averages for copra meal lots		47.9	4.2		19.8	4.4		22.7	4.0		

TABLE 6.—*Showing the plan of the experiment, the individual and the average yields and health conditions of trees under different fertilizer treatments, 1926*

	2.5 K. lime every 2 years			5.0 K. lime every 2 years			5 K. lime every 2 years + 0.48 K. P_2O_5 + 0.24 K. K_2O			Averages	
	Tree No.	Yield	Health condition	Tree No.	Yield	Health condition	Tree No.	Yield	Health condition	Yield	Health condition
0.25 K. N per tree per year in the form of 1.25 K. ammonium sulphate.	A 4	8	4	A 19	3	4	A 20	30	5	386.0	4.7
	B 278	190	5	B 277	40	5	B 257	180	4		
	B 134	514	5	B 135	1,834	5	B 157	675	5		
Averages	.....	237.3	4.7	.....	625.7	4.7	.....	295	4.7		
0.5 K. N per tree per year in the form of 2.5 K. ammonium sulphate.	A 21	9	4	A 23	137	5	A 24	140	4	432.0	4.7
	B 282	181	5	B 280	85	5	B 279	150	5		
	B 158	1,026	4	B 212	546	5	B 213	1,614	5		
Averages	.....	405.3	4.3	.....	256	5	.....	668	4.7		
0.75 K. N per tree per year in the form of 3.75 K. ammonium sulphate.	A 27	64	3	A 28	0	2	A 31	51	3	153.3	4.1
	B 304	250	5	B 303	40	5	B 301	0	5		
	B 214	640	5	B 253	15	5	B 293	320	4		
Averages	.....	318	4.3	.....	18.3	4	.....	123.7	4		
Vertical averages for ammonium sulphate plots	.....	320.2	4.4	.....	300	4.6	.....	351.1	4.4		
0.25 K. N per tree per year in the form of 10 K. copra meal	A 34	0	1	A 35	0	2	A 41	0	2	27.3	3.6
	B 247	180	4	B 244	37	5	B 242	0	5		
	B 68	10	5	B 69	9	3	B 93	10	5		
Averages	.....	63.3	3.3	.....	15.3	3.3	.....	3.3	4		
0.5 K. N per tree per year in the form of 20 K. copra meal	A 42	0	3	A 46	0	2	A 47	0	2	98.6	3.8
	B 232	284	4	B 227	3	5	B 225	3	3		
	B 94	100	5	B 113	413	5	B 115	84	5		
Averages	.....	128	4	.....	138.7	4	.....	29	3.3		
0.75 K. N per tree per year in the form of 30 K. copra meal	A 48	0	2	A 36	0	2	A 37	0	3	51.7	3.3
	B 300	50	5	B 299	45	5	B 298	150	5		
	B 116	190	2	B 117	6	3	B 45	25	3		
Averages	.....	80	3	.....	17	3.3	.....	58.3	3.7		
Vertical averages for copra meal lots	.....	90.4	3.4	.....	57.0	3.6	.....	30.2	3.7		

THE EFFECTS OF COVER CROPS ON TREES UNDER FERTILIZER EXPERIMENT NO. 7

To show the comparative values of tillage-cover crop and no tillage-continuous cover crop, combined with the use of lime and fertilizers, on the improvement of Batangas mandarin trees, Table 7 was made. All the trees included in Experiment No. 7 were grouped under the following cultural treatments:

1. Continuous cover crop of patani. No tillage except hoeing near the tree bases.
2. Continuous cover crop of *Tephrosia*. No tillage. Occasional cutting of cover crop growth and mulching the tree bases.
3. Continuous cover crop of cacahuate. No tillage. Occasional cutting of cover crop growth and mulching of the tree bases.
4. Tillage and cover crop. The ground was broken twice in a year and 1 or 2 temporary cover crops grown in the grove.
5. Light tillage and cover crop. The ground was broken lightly and a cover crop grown for about 6 months.

Discussion of results.—Table 7 gives the yields and conditions of the trees under Fertilizer Experiment No. 7, from 1925 to 1927. This table shows the following results:

1. A rapid improvement in the yield and condition of trees resulted from the combined use of a continuous cover crop of *Tephrosia* or of cacahuate and fertilizer. The yields and condition of trees for 1927, under these two leguminous cover crops were 258.3 fruits and 5 units, and 192.1 fruits and 4.8 units, respectively.
2. Patani used for continuous cover cropping made a poor showing.
3. Light tillage with a temporary leguminous cover crop in combination with the use of fertilizers proved only a fair system.
4. Tillage (ordinary depths) with temporary cover crops in combination with the use of fertilizers failed to improve the yield and conditions of the Batangas mandarin trees.

TOP-WORKING BATANGAS MANDARIN TREES

This work, which began in 1920, has established the fact that poor Batangas mandarin trees are easily top-worked because of their strong inclination to produce sprouts which are readily budded. Furthermore, as a stock the Batangas mandarin is of general adaptability.

TABLE 7.—*Yields and health conditions of trees grown under different kinds of cover crops, Fertilizer Experiment No. 7, 1925 to 1927*

Cover crop and cultural treatment	Year	Number of trees	Yields in number of fruits		Health conditions	
			Total	Average	Total	Average
1. Continuous cover crop of patani	1925	9	247	27.4	39	4.3
	1926	9	847	94.1	36	4.0
	1927	9	327	36.3	40	4.4
2. Continuous cover crop of *Tephrosia*	1925	6	27	4.5	25	4.2
	1926	6	327	54.5	26	4.3
	1927	6	1,550	258.3	30	5.0
3. Continuous cover crop of cacahuate	1925	9	286	31.8	42	4.7
	1926	9	7,184	798.2	43	4.8
	1927	9	1,729	192.1	43	4.8
4. Tillage and temporary cover crop	1925	12	49	4.1	25	2.1
	1926	12	115	9.8	27	2.3
	1927	12	281	23.4	43	3.9
5. Light tillage and temporary cover crop	1925	18	90	5.0	69	3.8
	1926	18	1,863	103.8	85	4.7
	1927	18	1,409	78.3	87	4.8

The test of varieties for top-working the mandarin carried on extensively since 1923, has shown, so far, that the following citrus varieties are best suited for this purpose, because of their commercial value, good bearing habits, and vigor:

Mandarin oranges: Selected Batangas, King, Kishiu and Szinkum.

Sweet oranges: Bahia; Balanga; Cajel, P. I. 966; Dougat; Homosassa; Majorca; Orange, P. I. 8868; Native No. 7; Native No. 8; Native No. 9; St. Micheal; Seville.

Pummeloes: Siamese S., P. I. 3442; Siamese S. P., P. I. 3673.

Miscellaneous citrus: Sampson tangelo, P. I. 1618; Calamondin; Carabao lime.

THE MAGUEY INDUSTRY OF ILOCOS NORTE

By LEONCIO DARIO
Agricultural Extension Agent

PREPARATION OF LAND

The greater part of the work of raising maguey is clearing the land. Usually it is covered with second-growth forest. Cutting down the trees, shrubs and other bushes, and piling and burning them is the first task. This condition obtains in the region between the municipality of Pasuquin and Burgos, and in a certain section of Bangui. In other places, especially along the sandy coast from the southern part of Pasuquin to Badoc, there is practically no clearing done except furrowing. No plowing is done preparatory to planting. In certain isolated rocky, hilly places, on the coastal section of Currimao, the removal of stumps of second-growth forest is also necessary.

In preparing one hectare of land preparatory to planting maguey, the procedure and expenditure are as follows:

1. Cutting down few second-growth trees but leaving roots and stumps in the ground, piling and burning them.

Expense.—One man working 10 hours a day at ₱1 per day without meals or ₱0.60 per day plus two meals, finishing the work in about 11 days, ₱11.

2. Clearing fairly thick bushes and second-growth forest trees, digging and removing roots and stumps, piling and burning them.

Expense.—Ten men of different working efficiency working ten hours a day at ₱0.60 per day without meals finishing the work in 41½ days, ₱249.

3. When the owner of the land with second-growth forest leases it to some one to clear by means of "caingin" to plant to upland palay or other crops for a year, the worker gets all the crop without giving any share to the owner. The next year the owner gets the cleared land and plants it to maguey. There is no actual outlay. But if the share of the owner of the land were to be paid in cash the owner would have spent for the clearing:

(*a*) Value of 4 uyones of palay at ₱15 per uyon.....	₱60.00
(*b*) Value of miscellaneous field crops.....	15.00
Total	75.00

4. Furrowing sandy or clay maguey land, without any or with only a few bushes.

(*a*) One man with plow and carabao working ½ day or 5 hours to finish the work.....	₱0.75

PLANTING

Planting maguey is done by drilling in hills, in rocky soils and on land with stumps and roots left standing; and, by placing

in furrows in clay and sandy soils. Suckers which are used for planting are generally 40 to 60 centimeters tall. Spacing varies greatly in different sections. In the northern section of the province, the spacing is 1 by 1 meter, 1 by 1.2 meters, and 1.2 by 1.2 meters; in the southern section of the province, it is 60 by 40 centimeters, 60 by 60 centimeters, 80 by 50 centimeters, 80 by 80 centimeters, 1 meter by 50 centimeters, 1 meter by 60 centimeters, 1 meter by 80 centimeters, and 1 by 1 meter. In general spacing in the northern section of the province is 1 by 1 meter and that in the southern section is 80 by 50 centimeters. Most of the old maguey fields are now overcrowded with unremoved suckers growing between the rows so that the original plan of spacing can no longer be recognized. It is claimed by those that practise close spacing that the plants protect each other from the ravages of stray animals and from being broken by strong winds.

Inasmuch as the expense of planting is generally based on the number of suckers planted, spacing is an important consideration. For purposes of the following computation, only the most common spacings practised, 1 by 1 meter and 80 by 50 centimeters, are considered.

For planting one hectare of land to maguey the expenses are as follows:

1. By administration, daily labor and wages.

(*a*) With 1 by 1 meter spacing:

Items	Cost per systen of planting	
	Drilled in hills	Furrowed on sandy or clay soil
For cost of 10,000 suckers at ₱3 per 1,000	₱30.00	₱30.00
For wages in gathering 10,000 suckers, 2 men working 6 days at ₱.60 plus two meals or ₱1 without meals per day each	12.00	12.00
For hauling 10,000 suckers, 1 man with cart and carabao working 2 days at ₱1.50 per day	3.00	3.00
For planting 10,000 suckers, 2 men at ₱1 per day each,—5 days' work by furrowing and 12 days by drilling	24.00	10.00
Total	69.00	55.00

(*b*) With 80 by 50 centimeters spacing:

For cost of 25,000 suckers at ₱3 per 1,000	₱75.00	₱75.00
For wages in gathering 25,000 suckers, 2 men working 15 days at ₱1 per day each	30.00	30.00
For hauling 25,000 suckers, 1 man with carabao and cart working 5 days at ₱1.50 per day	7.50	7.50
For planting 25,000 suckers, 2 men working 30 days by drilling in hills and 12.5 days by furrowing at ₱1 per day each	60.00	25.00
Total	172.50	137.50

2. By contract, paid in cash.

(*a*) With 1 by 1 meter spacing:

For cost of 10,000 suckers at ₱3 per 1,000	₱30.00	₱30.00
For gathering 10,000 suckers at ₱2 per 1,000	20.00	20.00
For hauling 10,000 suckers at ₱2 per 1,000	20.00	20.00
For planting 10,000 suckers at ₱3 per 1,000—by drilling in hills and ₱1 per 1,000 by furrowing	30.00	10.00
Total	100.00	80.00

(*b*) With 80 by 50 centimeters spacing:

For cost of 25,000 suckers at ₱3 per 1,000	₱75.00	₱75.00
For gathering 25,000 suckers at ₱2 per 1,000	50.00	50.00
For hauling 25,000 suckers at ₱2 per 1,000	50.00	50.00
For planting 25,000 suckers at ₱3 per 1,000 by drilling in hills and ₱1 per 1,000 by furrowing	75.00	75.00
Total	250.00	250.00

3. By contract, share basis.

(*a*) A laborer clears the land of the second-growth forest and plants it by drilling in hills with a spacing of 1 by 1 meter. The worker receives as compensation for his labor one-half of the maguey that may be raised yearly. In this particular case, the laborer invests only ₱80, which is the value of his labor. After three or four years the laborer will be getting from his share, one-half hectare planted to maguey, a yearly gross income of not less than ₱160 worth of fiber—20 piculs at ₱8 per picul. Considering three-fourths of the gross income as the highest possible expense for labor in preparing the fiber, the laborer would be making a yearly net income of ₱40 during a period of 20 years, or a net income of ₱800 in a period of 20 years of productivity.

(*b*) A laborer clears the land of the second-growth forest, plants it by drilling in hills, with a spacing of 1 by 1 meter. The worker harvests the crop without giving any share to the owner for a period of 5 years. After this period the owner takes over the whole plantation, that is, the laborer is given 5 years' crop as compensation. In this case the laborer invests only a capital of ₱80 which is the value of his labor. During the 5-year period the laborer would realize a total gross income of ₱1,600 estimating an average yield of 40 piculs clean fiber per hectare, at ₱8 per picul. Considering three-fourths of the product or its gross value as the highest probable cost of production, the laborer would be making a net income of ₱400. The owner in this particular case would be incurring a net loss of ₱400 minus ₱80 or ₱320.

In the absence of any other means of developing the land because the owner cannot work it himself or cannot afford the small amount of money to invest, the system of contract by the share basis is the best means to effect development.

CULTIVATION

Practically the plantation is not cultivated after planting. The only cultivation practised, in general, is the cutting down of shrubs and the removal of suckers that bother the harvesters at harvest time. This practice is resorted to only once a year and yet it is not done thoroughly because only those shrubs and suckers that happen to get in the harvesters' way are removed. Maguey plantation owners do not make any attempt to have their lands cleaned thoroughly of unnecessary trees and shrubs, and unnecessary overcrowding suckers even once a year. In plantations where the space between the rows could be cultivated by plow or other implements, this is not done either. As a result of this general local indifference, the plantations become overcrowded with suckers and other growths after 5 years, which is one of the causes of low yield.

HARVESTING AND RETTING

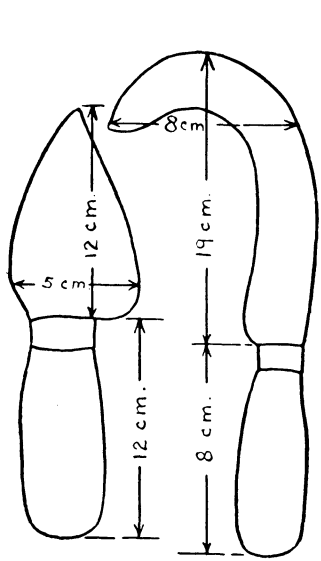
The harvesting and retting season generally extends from the close to the beginning of the rainy season, that is, from November to June of the following year. In places where they have a safe place for retting or where they have enough maguey leaves to work with during the rainy season, harvesting goes on throughout the year.

The general practice is to gather the leaves once a year. There are a few places though where harvesting is done once every two years. From ten to thirty-five leaves are cut from plants that are yearly cropped, and from thirty to eighty leaves from plants that are cropped every two years or more. Because of the scarcity of labor in the locality, there are places like Karoan, Nagsanga, Pasuquin and others where harvesting is done at three or more year intervals. From four to twelve leaves, generally six or eight excluding the young unopened bud, are left on each plant.

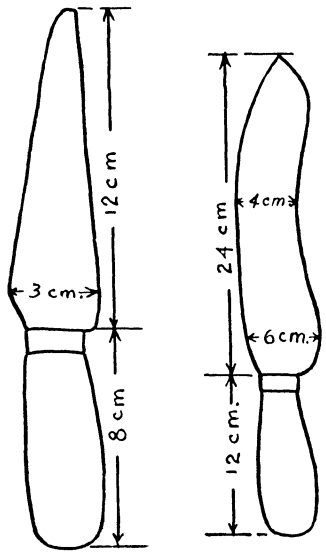
Tools made for the purpose are used in cutting and stripping the leaves. (See page 187.)

It is the practice of the majority of those that ret the leaves in salt water to split them into halves and also to cut off the butt end of the leaves halfway the tip. In a few cases the leaves are split into four sections. Those that ret in fresh water split the leaves into several pieces, 1 to 2 centimeters wide, with the aid of the special tools and with other ordinary tools. The process is very slow and the workers take more time to split the

same quantity of leaves to be retted in fresh water than in salt water.



For cutting leaves



For removing spines and for splitting leaves

It has been observed in several places that there are enough maguey leaves to harvest to provide the people continuous work for only two months. The laborers in some places are, however, unwilling to harvest maguey and as a result, in such places it is left unharvested for years. It has also been noted that some of the laborers engaged in the local maguey harvest are from the neighboring province of Ilocos Sur. They work on the contract, share basis.

Harvesting maguey is sometimes done by coöperative labor termed locally "ammuyo," where the owner provides the workers with two meals, and sometimes drinks and "buyo"; and, also, by contract the payment being made in cash or in kind. Harvesting by administration on the daily wage basis is never done. The principal unit bases in these contracts are the bundle of harvested leaves, cut, split and bundled for retting or for washing; and, the picul weight equivalent to 64 kilos, in case of already cleaned fiber. It must be noted that 64 kilos go to a picul instead of the standard 63 kilos only. The additional kilo is allowed for extra weight of bundling materials and moisture in the fiber. The size of the bundles of leaves that are ready for retting varies greatly according to usage in the dif-

ferent localities and according to the size of the leaves. The bundles are generally from 8 to 30 centimeters in diameter. The most common sizes are 10, 15, and 20 centimeters. The average size of the bundles is 16.75 centimeters in diameter. A picul of fiber can be produced from 118 bundles of this size made up of mixed sizes of leaves, that is, leaves from 60 centimeters long and 5 centimeters wide to 2 meters long 12 centimeters wide, mostly leaves 80 centimeters to 1.2 meters long and 6 to 10 centimeters wide. An average laborer can cut, split and bundle 29 bundles of maguey leaves for retting and wash and clean 65 bundles of retted maguey leaves 16.75 centimeters in diameter in a day.

The following shows the relative efficiency of workers:

1. Good worker:

(*a*) One man who cuts, splits, bundles 75 to 100 bundles of the 15- to 20-centimeter diameter or 120 to 200 bundles of the 8- to 12-centimeter diameter per day; and washes per day 100 to 150 bundles of the 15- to 20-centimeter or 150 to 225 bundles of the 8- to 12-centimeter diameter or cleans enough bundles to produce 1 to 2 piculs clean fiber.

(*b*) One woman who cuts, splits and bundles 50 to 70 bundles of the 15- to 20-centimeter diameter or 100 to 150 bundles of the 8- to 12-centimeter diameter per day; and washes 75 to 125 bundles of the 15- to 20-centimeter diameter or 125 to 175 bundles of the 8- to 12-centimeter diameter or enough to produce 50 kilos to 100 kilos clean fiber per day.

(*c*) One boy or girl who cuts, splits and bundles 35 to 50 bundles of the 15- to 20-centimeter diameter or 75 to 100 of the 8- to 12-centimeter diameter per day; and washes 50 to 60 bundles of the 15- to 20-centimeter diameter or 80 to 120 bundles of the 8- to 12-centimeter diameter or enough bundles to produce 30 to 64 kilos of clean fiber per day.

2. Fair worker:

(*a*) One man who cuts, splits and bundles 30 to 60 bundles of the 15- to 20-centimeter diameter or 80 to 120 bundles of the 8- to 12-centimeter diameter per day; and washes 75 to 100 bundles of the 15- to 20-centimeter diameter or 100 to 160 bundles of the 8- to 12-centimeter diameter or enough bundles to produce 75 to 90 kilos clean fiber per day.

(*b*) One woman who cuts, splits and bundles 20 to 40 bundles of the 15- to 20-centimeter diameter or 50 to 80 bundles of the 8- to 12-centimeter diameter per day; and washes 50 to 75 bundles of the 15- to 20-centimeter diameter or 80 to 100 bundles of the 8- to 12-centimeter diameter or enough bundles to produce 40 to 60 kilos of clean fiber per day.

(*c*) One boy or girl who cuts, splits and bundles 10 to 25 bundles of the 15- to 20-centimeter diameter or 30 to 50 bundles of the 8- to 12-centimeter diameter per day; and washes 20 to 40 bundles of the 15- to 20-centimeter diameter or 50 to 75 bundles of the 8- to 12-centimeter diameter or enough bundles to prduce 10 to 25 kilos of clean fiber per day.

A group of 3 to 5 persons is the best to effect the maximum rate of efficiency.

The rate of wages commonly in use in this province is as follows:

1. For cutting, splitting and bundling leaves ready for retting: ₱1.30 to ₱2 for every 100 bundles, 15 to 20 centimeters in diameter; ₱3 to ₱4 for every 100 bundles, 25 to 30 centimeters in diameter; and ₱1 for every 100 bundles, 8 to 12 centimeters in diameter.
2. For hauling bundles of leaves from field to water, 1 to 3 kilometers distance and retting them: ₱1 for every 100 bundles, 15 to 20 centimeters in diameter; and ₱0.50 for every 100 bundles, 8 to 12 centimeters diameter.
3. For washing retted leaves and drying fibers: ₱1 per 100 bundles, 15 to 20 centimeters in diameter; ₱0.50 per 100 bundles, 8 to 12 centimeters in diameter; and ₱1.50 per picul, dry clean fiber.
4. For cleaning fiber well and baling: ₱0.20 to ₱0.30 per picul when fiber has plenty of dirt or unsound portion to be removed; ₱0.10 per picul when fiber is fairly well cleaned; and ₱0.05 per fardo, 32 kilos weight.

The division between workers and owners varies as follows:

1. When the plantation is close to water: (*a*) Workers get $\frac{3}{8}$ of the fiber; owner gets $\frac{5}{8}$ of the fiber. (*b*) Workers get $\frac{1}{2}$ of the fiber; owner get $\frac{1}{2}$ of the fiber. In some cases the owner will have to pay for the cost of hauling the bundled leaves to the water.
2. When water for retting is far from the plantation: (*a*) Workers get $\frac{5}{8}$ of the fiber; owner gets $\frac{3}{8}$ of the fiber. (*b*) Workers get $\frac{3}{4}$ of the fiber; owner gets $\frac{1}{4}$ of the fiber.
3. When the worker and owner divide the crop as bundled leaves ready for retting: (*a*) Workers get $\frac{1}{2}$ of the quantity of bundled leaves; owner gets $\frac{1}{2}$ of the quantity of bundled leaves.

The owner pays the worker cash for hauling and retting his share and for washing and drying as per regular rate according to the size of the bundles.

(*b*) Worker gets $\frac{1}{2}$ of the bundled leaves, for cutting, splitting and bundling the leaves and for washing and drying the retted leaves; owner gets $\frac{1}{4}$ of the bundled leaves; cartman gets $\frac{1}{4}$ of the bundled leaves for hauling and retting.

(*c*) Worker gets $\frac{1}{3}$ of the bundled leaves; owner gets $\frac{2}{3}$ of the bundled leaves.

The most common basis for dividing the crop is $\frac{1}{3}$ or $\frac{1}{2}$ to the owner and $\frac{2}{3}$ or $\frac{1}{2}$ to the worker. In the majority of cases the worker gets the bigger share.

Intelligent and experienced workers contract to work by paying cash or often act as middlemen in harvesting maguey. They go to owners of plantations and contract to harvest the leaves for a certain sum. This practice is always disadvantageous to the owners. The general practice under this system

of harvesting the maguey is to pay for the number of plants in the entire lot in cash as per agreement between owners and contractors. The following are actual illustrations of the system:

1. Some workers at Araniw, Laoag, contracted to pay the owners ₱0.01 for every three plants, that is, the harvestable leaves of three plants. The leaves of three plants are sufficient to produce 1 kilo of clean fiber more or less. At the lowest prevailing price of ₱0.12 per kilo of the fiber, the contractors made a profit of ₱0.03 or ₱0.02 for every ₱0.01 invested after deducting $\frac{2}{3}$ or $\frac{3}{4}$ of the gross income as the share of the workers. The owner in this particular case realized a gross income of only ₱33.33 per hectare on the basis of 10,000 plants to the hectare.

2. A woman contractor at Boraan, Burgos acting as middleman, contracted for the crop of a maguey farm containing 3,500 square meters for ₱40. This particular plantation actually yielded 15 piculs. At the regular price of ₱8 per picul, she made ₱120. Taking from this gross income $\frac{1}{2}$ as the shares of the workers and the ₱40 for the owner of the plantation, she realized a net profit of ₱20.

3. A person in barrio No. 4, Badoc, employing 5 workers—1 man, 1 woman, and 3 young men—contracted for the maguey crop paying ₱500 for all. The workers were employed 60 days. After giving $\frac{1}{2}$ of the gross returns which totaled ₱600, to the workers the contractor still made a net gain of ₱100. The laborers in this particular case were able to earn ₱2 each a day.

The number of days it takes for retting a bundle of leaves varies according to the size of the bundles, the different periods during the year, general local practice—whether pounding on washing or not and the place for retting—whether fresh or salt water. Conditions being the same, the bigger bundles require more days in water than the smaller ones; more stone covering of the pile to prevent the leaves from being carried away by the current especially in the sea require more days than ordinary covers; retting during the cold months from November to February requires more days in water than during the hot weather from March to June; and the leaves retted in fresh water are kept in water less days than in salt water because the workers remove the pulp by pounding while in salt water they remove the pulp by washing.

In general, bundles of 10 to 15 centimeters in diameter retted in salt water require 12 to 15 days in water during the months of November to February and 8 to 10 days from March to June. During this immersion the retted leaves require only a little pounding to clean the fiber and it is estimated that about a tenth of the retted leaves require pounding. Bundles of the same dimension retted in fresh water require 10 to 14 days

during the period from November to February and 8 to 10 days from March to June. The majority of the retted leaves require pounding on washing. This process requires more labor and is slower than that in salt water.

The ease with which retted maguey leaves are cleaned is one of the important factors which governs the rate of efficiency of the workers. It is thus seen that workers will earn less by pounding the retted leaves than by merely keeping them in water longer in order to wash them easier and extract a greater quantity of fiber at a given time.

The cost of harvesting and retting from a given area can be estimated from the following data:

1. Plantation with at least 25,000 plants to the hectare:

One bundle 15 to 20 centimeters in diameter is made up of 65 to 80 leaves or an average of 75 leaves, 0.8 to 1 meter long, 5 to 6 centimeters wide. The leaves cut from 5 plants suffice to make a bundle as above. A picul of fiber is produced from 120 bundles.

2. Plantation with at least 10,000 plants to the hectare:

One bundle 15 to 20 centimeters in diameter is made up of from 40 to 60 leaves or an average of 45 leaves, 1.2 to 1.8 meters long, 8 to 12 centimeters wide. Leaves cut from 2 plants make a bundle of the dimension mentioned above. A picul of fiber is produced from 75 bundles.

3. The scale of daily wages for a ten-hour working day without meals is ₱1 per day for a man, ₱0.60 for a woman, and ₱0.40 for a boy or girl.

In the harvesting and retting of maguey leaves from a hectare plantation, the procedure and expenditure are as follows:

1. By administration, daily wage basis:

(*a*) One hectare plantation with at least 25,000 plants to the hectare:

For cutting, splitting and bundling the leaves from 1 hectare at the rate of 95 bundles a day, 3 regular laborers—one man, one woman, and a boy or girl—working during 52.5 days at ₱2 per day	₱105.00
For hauling and retting 5,000 bundles, one man with cart and carabao working 10 days at ₱1.50 per day	15.00
For washing 5,000 bundles of retted leaves and drying the fiber, 3 laborers as per above working 27.5 days at ₱2 per day	55.00
For cleaning and baling the crop from 1 hectare, 41.66 piculs of clean fiber, one man working 8 days at ₱1 per day	8.00
Total	183.00

(*b*) One hectare plantation with at least 10,000 plants to the hectare:

For cutting, splitting and bundling the leaves from 1 hectare at the rate of 95 bundles a day, 3 regular laborers—one man, one woman, and a boy or girl—working 52.5 days at ₱2 per day	₱105.00
For hauling 5,000 bundles from field to water and retting them, one man with cart and carabao at ₱1.50 per day working 10 days	15.00
For washing 5,000 bundles of retted leaves and drying the fiber, 3 laborers as above working 27.5 days at ₱2 per day	55.00
For cleaning and baling the crop from 1 hectare, 66.66 piculs clean fiber, one man working 13.5 days at ₱1 per day	13.50
Total	188.50

2. By administration, contract basis:

(*a*) One hectare plantation with at least 25,000 plants to the hectare:

For cutting, splitting and bundling 5,000 bundles at ₱2 per 100 bundles	₱100.00
For hauling 5,000 bundles from field to water and retting them at ₱1 per 100 bundles	50.00
For washing 5,000 bundles of retted leaves and drying the fiber at ₱1 per 100 bundles	50.00
For cleaning and baling the crop from 1 hectare, 41.66 piculs at ₱0.20 per picul	8.33
Total	208.33

(*b*) One hectare plantation with at least 10,000 plants to the hectare:

For cutting, splitting and bundling 5,000 bundles at ₱2 per 100 bundles	₱100.00
For hauling from field to water 5,000 bundles and retting them at ₱1 per 100 bundles	50.00
For washing 5,000 bundles and drying the fiber at ₱1 per 100 bundles	50.00
For cleaning and baling the crop from 1 hectare, 66.66 piculs at ₱0.20 per picul	13.33
Total	213.33

3. By contract, share basis:

(*a*) One hectare plantation with at least 25,000 plants to the hectare:

Proportion of shares		Share of owners		Share of workers	
Owner	Worker	Number in piculs of fiber	Total value at ₱8 per picul	Number in piculs of fiber	Total value at ₱8 per picul
One-half	One-half	20.830	₱166.64	20.830	₱166.64
Two-fifths	Three-fifths	16.664	133.31	24.996	199.97
One-third	Two-third	13.886	111.09	27.772	222.18
One-fourth	Three-fourths	10.415	83.32	31.245	249.96

(*b*) One hectare plantation with at least 10,000 plants to the hectare:

Proportion of shares		Share of owners		Share of workers	
Owner	Worker	Number of piculs of clean fiber	Total value at ₱8 per picul	Number of piculs of clean fiber	Total value at ₱8 per picul
One-half	One-half	33.330	₱266.64	33.330	₱266.64
Two-fifths	Three-fifths	26.664	213.31	39.996	319.97
One-third	Two-thirds	22.220	177.76	44.440	355.52
One-fourth	Three-fourths	16.665	133.32	49.995	399.96

(*c*) When the owners and workers divide the crop as bundled leaves ready for retting, their corresponding shares per hectare are:

Proportion of shares		Share of owner			Additional expenses of owner in preparing the fiber	Share of worker		
Owner	Worker	Number of bundles	Equivalent number of piculs of fiber	Total value at ₱8 per picul		Number of bundles	Equivalent number of piculs of fiber	Total value at ₱8 per picul
One-half	One-half	2,500	[a] 20.83	₱166.64	₱54.17	2,500	[a] 20.83	166.64
			[b] 33.33	266.64	56.50	.....	[b] 33.33	266.64
Two-thirds	One-third	3,333.3	[a] 27.772	222.18	72.55	1,666.7	[a] 13.886	111.09
			[b] 44.440	355.52	75.55	.....	[b] 22.220	177.76

[a] From one hectare plantation containing at least 25,000 plants per hectare.
[b] From one hectare plantation containing at least 10,000 plants per hectare.
[c] Cost of hauling, washing, drying and baling which is credited against the share of the owner.

4. Coöperative work or "Ammuyo."

Under this system planters actually spend less than they should as may be noted in the following:

(*a*) One hectare plantation with at least 25,000 plants to the hectare:

For food, 2 meals, daily, drinks, etc. of 15 persons working 10.5 days to cut, split and bundle the leaves from the plantation	₱47.25
For food, 2 meals daily, drinks, etc. of 2 men with cart hauling bundled leaves and retting them during 5 days	3.00
For food, 2 meals daily, drinks, etc. of 15 persons working 5.5 days to wash retted leaves and dry the fiber	24.75
For food, 2 meals daily, drinks, etc. of 1 man working 8 days cleaning and baling 41.66 piculs clean fiber	2.40
Total	77.40

(*b*) One hectare plantation with at least 10,000 plants to the hectare:

For food, 2 meals, and drinks, etc. of 15 persons working 10.5 days to cut, split, and bundle harvestable leaves from the plantation	₱47.25
For food, 2 meals per day, drinks, etc. of two men with cart working 5 days hauling bundled leaves and retting them	3.00
For food, 2 meals daily, drinks, etc. of 15 persons working 5.5 days washing the retted leaves and drying the fiber	24.75
For food, 2 meals per day, drinks, etc. of 1 man working 13.5 days cleaning and baling 66.66 piculs of fiber	4.05
Total	79.05

ACTUAL YIELDS

From some selected fields which were visited where the owners or the men in charge could give the actual yields, and where the author of this article was able to determine the actual condition of the plants the following data were obtained:

1. Plantations containing at least 25,000 plants to the hectare:

One in Currimao	6.0	hectares	yielding	120	piculs each year
One in Bubon, Burgos	1.5	hectares	yielding	30	piculs each year
One in Bubon, Burgos	4.0	hectares	yielding	60	piculs each year
One in Pasuquin	2.25	hectares	yielding	50	piculs each year
One in Davila, Pasuquin	3.0	hectares	yielding	50	piculs each year
One in Badoc	1.0	hectare	yielding	30	piculs each year
Total	17.75	hectares	yielding	340	piculs each year

Average actual yield per hectare—19.155 piculs yearly.

2. Plantations containing at least 10,000 plants to the hectare:

One in Currimao	0.3	hectare	yields	13	piculs every year
One in Boraan, Burgos	0.03	hectare	yields	3	piculs every year
One in Boraan, Burgos	0.35	hectare	yields	15	piculs every year
One in Davila, Pasuquin	0.09	hectare	yields	3	piculs every year
One in Davila, Pasuquin	0.06	hectare	yields	2	piculs every year
One in Davila, Pasuquin	0.20	hectare	yields	8	piculs every year
One in Nagabungan, Pasuquin	0.04	hectare	yields	1	picul every year
Total	1.07	hectares	yield	43	piculs every year

Average actual yield per hectare—40.187 piculs yearly.

3. Plantations containing at least 10,000 plants to the hectare, harvested once every two or more years:

One in Nagsanga, Pasuquin	0.03	hectare yields	2.77 piculs
One in Natbawan, Pasuquin	1.70	hectares yield	73.00 piculs

One in Pasuquin	2.25 hectares	yield 90.00 piculs
One in Pagudpud, Bangui	1.20 hectares	yield 120.00 piculs
Total	5.13 hectares	yield 285.77 piculs

Average actual yield per hectare—55.706 piculs.

Good plants producing leaves 1.3 to 2 meters long and 8 to 12 centimeters wide and cropped yearly, will yield 50 to 75 piculs from one hectare; ordinary sized plants, 30 to 50 piculs. Plantations that are cropped once every two years generally yield 80 to 100 piculs every harvest.

Actual observation and study makes it safe to assert that the maguey fields in Ilocos Norte give the following yields:

First-class plantation—50 piculs of clean fiber yearly per hectare.
Second-class plantation—40 piculs of clean fiber yearly per hectare.
Third-class plantation—30 piculs of clean fiber yearly per hectare.
Fourth-class plantation—20 piculs of clean fiber yearly per hectare.

CLASSIFICATION

In general the producers, both owners and workers, do not attempt to classify the fiber. They mix long and short, sound and unsound, and white and brownish. Some producers do not clean and dry the fiber very well before placing it on the market, thinking that they get heavier product per unit quantity this way than if it were well cleaned and dried, which accounts for the low prices offered. Generally the greater part of the local maguey is third and fourth-class fiber.

In a few exceptional cases, workers, especially those from the Province of Ilocos Sur, take pains in classifying the cut leaves before splitting and bundling them for retting, that is, they put sound leaves of uniform length together. Leaves of uniform length but having scars and wounds are put in separate bundles.

The following is the general classification of leaves as to length and size and soundness:

First-class leaves—1.5 to 2 meters long, 10 to 12 centimeters wide.
Second-class leaves—1.1 to 1.4 meters long, 8 to 10 centimeters wide.
Third-class leaves—0.8 to 1 meter long, 7 to 8 centimeters wide.
Fourth-class leaves—less than 0.8 to 0.8 meter long and less than 6 to 6 centimeters wide.

For every 100 piculs of fiber, maguey from Ilocos Norte compares with that from Sinait, Ilocos Sur as follows:

Locality	Classification				
	First	Second	Third	Fourth	Total
Ilocos Norte	None	5	40	55	100
Sinait, Ilocos Sur	None	60	35	5	100

MARKETING

The producers, both owners and workers are greatly handicapped in the marketing of their product because of their ignorance of the elementary principles of agricultural economics and the business side of farming. As a result, merchants and middlemen reap the profit that should go to them from the maguey crop raised.

Most of the producers sell their crop right in their respective localities to small local merchants, representatives of Chinese merchants of Laoag and to middlemen for cash or in exchange for other goods, usually rice and canned goods. Few producers sell their crops to merchants in Laoag, especially those from the northern part of the province; those from the southern part, to merchants in Sinait and Vigan, Ilocos Sur. The big merchants sell the fiber to Manila exporters.

The following were the current prices in the different maguey producing localities during the latter part of January 1928, and also the cost of marketing and current prices at central markets of local producers.

Producing localities	Local price of fiber per picul	Central market for product	Current prices at central market per picul	Distance of producing locality to central market	Cheapest transportation expenses per picul			Difference in favor of central market
					Truck	Bull cart	Sail boat	
	Pesos		*Pesos*	*Km.*	*Pesos*	*Pesos*	*Pesos*	*Pesos*
Laoag and San Nicolas	8.50	Laoag	10.00	5	.....	0.10	.....	1.40
Sarrat, Vintar and Bacarra	8.50	...do...	...do...	10	.....	0.30	.....	1.30
Pasuquin	9.50	...do...	...do...	16	.....	0.30	.....	0.30
Davila, Pasuquin	9.00	...do...	...do...	30	0.50	0.50	.....	0.50
Bubon	8.50	...do...	...do...	35	0.55	0.55	.....	0.95
Buraan	8.00	...do...	...do...	40	0.60	0.60	.....	1.40
Bangui	8.00	...do...	...do...	64	1.00	.....	.....	1.00
Laoag	8.50	Currimao	11.00	30	0.20	.....	.....	2.30
Paoay	10.00	...do...	...do...	7	0.10	0.10	.....	0.90
Batac	10.00	...do...	...do...	12	0.10	0.10	.....	0.90
Badoc	11.50	Sinait	12.00	8	.....	0.20	.....	0.30
Currimao	11.00	Vigan, I. Sur.	12.00	55	.....	.....	0.30	0.70
Laoag	8.50	...do...	...do...	84	1.00	.....	.....	2.50
Bangui	8.00	...do...	...do...	148	2.00	.....	.....	2.00

From this table, it can be seen that the local producers could get higher prices by doing the marketing themselves especially if coöperatively. The differences as presented in the above table represent a loss to the direct producers and generally a gain to the small merchants, middlemen and others, who buy most of the fiber from the producers right in their respective localities.

The following illustrates the local bartering system:

Merchandise bartered			Maguey fiber exchanged			
Kind of goods	Quantity	Actual value of goods	Number of kilos	Average unit cash value per kilo	Actual cash value of fiber	Net loss of producer in transaction
		Pesos		*Pesos*	*Pesos*	*Pesos*
Rice	1 cavan	9.30	96	[a]0.145	13.92	4.62
Do	1 ganta	.40	6	do	.87	.47
Corned beef	1 can	.45	5	do	.72	.27
Sardines	do	.22	3	do	.43	.21
Salmon	do	.28	4	do	.58	.30
Wine	1 "frasco"	.80	10	do	1.45	.65

[a] Average of the different local prices in places of production in Ilocos Norte as shown in the preceding table.

The big local merchants sell the fiber to exporters in Manila. Some of the Manila buyers prefer and pay more for salt water retted fiber while others prefer fresh water retted fiber. Machine cleaned fiber costs from ₱2 to ₱3 more per picul than retted maguey.

The prices paid to Ilocos Norte maguey fiber by Manila buyers are generally as follows:

	Per picul
Lot price, mixed classes	₱11.00
Second-class fiber	13.75
Third-class fiber	12.50
Fourth-class fiber	10.00

The local merchants incur the following expenses in the marketing of 1 picul of fiber from Laoag to Manila:

Transportation by bull cart or truck, Laoag to Currimao	₱0.20
Storage charges at Currimao	0.05
Wharfage charges at Currimao	0.02
Loading charges at Currimao, bodega to steamer	0.23
Freight on steamer, Currimao	0.65
Unloading, hauling and storage charges in Manila	0.30
Merchants sales tax (1.5 per cent of ₱11, lot price)	0.17
Commission of agent in Manila (3 per cent of ₱11)	0.33
Deductions due to loss in weight or "reseco" (5 per cent of ₱11)	0.55
Total	₱2.50

Generally, Manila buyers charge only 1 per cent for loss in weight; but for Ilocos Norte fiber they charge 5 per cent because it is dirty and wet. Local producers dry the fiber only one day. Others do not clean the fiber well so that it will weigh more.

GENERAL COST OF PRODUCTION

The following table shows the cost of production under different conditions:

Items	Plantation with 25,000 plants per hectare		Plantation with 10,000 plants per hectare	
	Clay or sandy soil	Stony soil with trees	Clay or sandy soil	Stony soil with trees
Preparation of land	₱0.75	₱249.00	₱0.75	₱249.00
Fencing with barbed wire	120.00	120.00	120.00	120.00
Planting by contract, cash basis	200.00	250.00	80.00	100.00
Cultivation once a year or more	6.00	10.00	6.00	10.00
Harvesting, retting, drying and baling by contract, cash basis	220.82	220.82	263.32	263.32
Total cost of production per hectare	547.57	849.82	470.07	742.32

Under existing conditions, these expenses are the highest probable expenditures that will be incurred in a hectare maguey plantation under the best cultural treatment possible in the locality.

Basing the estimate on the highest cost of production and the average local price of ₱9.32 per picul paid to producers in the different places as given elsewhere in this report, the plantation as mentioned in the preceding table must at least give the following yield in order to be able to pay expenses.

One hectare plantation	First harvest		Second and subsequent harvests	
	Sandy or clay soil	Stony soil with trees	Sandy or clay soil	Stony soil with trees
	Piculs	*Piculs*	*Piculs*	*Piculs*
25,000 plants	58.645	91.182	24.337	24.776
10,000 plants	50.436	79.648	28.900	29.326

A plantation with 25,000 plants to the hectare when yielding only 19.185 piculs per hectare every year can not make a profit and will never pay the actual cost of production by the contract system, cash basis. The planters can make a profit only through the contract system, share basis, in which case the plantation can completely cover the expenses after the ninth harvest in sandy or clay soil or fourteenth harvest in stony soil and can make a yearly net profit of ₱59.60 thereafter, when the owner's share would be $\frac{1}{3}$ of the crop or 6.395 piculs every harvest. It must be noted, however, that under different conditions as enumerated elsewhere in this report, the same plantation is capable of producing 25 piculs, 30 piculs and 41.66 piculs per hectare, with a proportionate increase in profit.

On the other hand, a plantation with 10,000 plants per hectare giving 40.187 piculs yearly can pay the whole cost of production and make ₱9.67 net profit after the second harvest and ₱105.19 net profit on subsequent harvests by the contract system, cash basis, in the case of sandy or clay soil; and in the case of stony soil the plantation can completely pay the cost of production from the fifth crop with a net profit of ₱36.94 and in subsequent harvests with a yearly net profit of ₱101.25.

Under present conditions the best system to insure profit to owners of plantations is by the contract system, share basis.

GENERAL REMARKS

The present maguey plantations are in most cases neglected. Producers do not follow the best cultural practices in order to produce the greatest quantity and the best quality of product. Plantations are overcrowded with suckers, unprotected by fences from stray animals and uncultivated. There are, however, a few small new plantations here and there that are fairly good as to general vigor and growth but they are also uncultivated.

Producers in general do not, in the majority of cases, attempt to classify the product. As a result, the local maguey is losing its prestige among discriminating merchants. Some producers too do not attempt to clean their product well and do not dry the fiber thoroughly so it will weigh heavier; on the other hand, there are local merchants too that in their desire to secure greater profit do not pay higher prices for better product commensurate with the extra labor done by the producers in the production of clean, well dried fiber. Both practices are destructive to the industry and should be discouraged.

Because of the present low actual yield of local plantations it is to the mutual interest of both owners and workers to divide the crop produced on a contract, share basis: one-half to owner and one-half to the worker, the owner bearing the expenses of hauling; or, one-third to owner and two-thirds to workers, all expenses to be borne by the worker being the best arrangement. The owners will make a little net profit on their investments after some harvests as may be seen elsewhere in this report and the workers too will realize fairly high wages from the value of their shares. In this case, man-labor receives an equivalent value of his earnings as from ₱0.92 to ₱2 per day or an average of 1.435, woman-labor from ₱0.65 to ₱1.50 per day or an average of ₱1.078, and boy or girl from ₱0.48 to ₱0.90 or ₱0.69.

Under prevailing general local practices, the workers are receiving the greatest benefit from the industry. It is the best means at present from which they can derive a reasonable income. Merchants too make a considerable profit. Owners who do not work the plantation and depend solely on the labor of others do not get much profit on their investment at present. However, if owners can produce a yield of 50 piculs or more per hectare, they can get one of the most comfortable incomes that can be obtained from a farm under local conditions.

There is sufficient local labor supply at present engaged in the industry. There are, though, places where local labor is reluctant to work because it is not used to it. However, labor from Ilocos Sur is available. The local acreage of the plantations is not sufficient to provide enough work for laborers who are actually engaged in the work at present. Most of the planted areas are sufficient to provide work for only two months. There are still extensive areas available for planting maguey in the best maguey districts of this province. If these areas could only be made available to workers so that they could build their homes on them and work them, a family would be able to take care of a plantation 3 to 5 hectares in extension and would be able to make a gross income of not less than ₱1,000 to ₱2,000 a year, under present conditions, devoting their full attention to maguey as their major crop.

The producers are not getting the full money value of their products because they are not able to handle wisely the marketing of their crops. This is due to the lack of sufficient knowledge in the elementary principles of agricultural economics and the business side of farming among the producers. The organization of a producers' coöperative association among the maguey producers in this province would be a great help.

FROM OUR CONTEMPORARIES

POSTAL REVENUE FOR GRASSHOPPER CONTROL

During the past few years Mexico suffered enormous losses from the attacks of grasshoppers. To combat this pest funds were created from the sale of additional one-centavo stamps which were decreed by the President to be carried on all domestic matter in addition to the regular postage.—*Journal of Economic Entomology.*

An improved method of protecting fowls against chicken pox by vaccination has been discovered by Dr. J. R. Beach. The vaccine is made from the entire combs of cockerels killed from nine to twelve days after inoculation with the chicken pox virus. The vaccine "is capable of producing in fowls within twenty-eight days after administration either complete immunity or a high degree of resistance to artificial infection with chicken pox virus."—*The California Countryman.*

RED SQUILL AS A RAT POISON

The poison is extracted from the red squill bulb (*Urginea maritima*) which abounds on the sandy shores of the Mediterranean Sea. It may be applied in the powdered or liquid form, by bread, or mixed with fat or syrup.—*The Agricultural Gazette of New South Wales.*

CLOVER AND MALARIA

"In a letter to *The Times* of August 29, Sir William Willcocks, writing from Cairo, relates cases of where the introduction of the wild clover plant into parts of the Argentine and Holland secured the disappearance of the malaria mosquito in those parts, and how the profusion of clover fields in the Delta of the

Nile, which are allowed to flower profusely, through months of the year, saved Egypt from the malaria mosquito."—*Tropical Life.*

The prevalence of sugar-cane mosaic and root diseases in the state of Louisiana and other parts of the South has led to the organization by the United States Department of Agriculture of an expedition under the leadership of Dr. E. W. Brandes, sugar plant specialist, that will search the wilds of New Guinea for disease-resistant cane varieties. Sugar cane is believed to be indigenous to New Guinea. An airplane will be used by the party, which is composed of prominent sugar-cane specialists.—*The Planter and Sugar Manufacturer.*

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Hon. JORGE B. VARGAS

Under Secretary of Agriculture and Natural Resources

Formerly Assistant Director of Commerce and Industry, Acting Director of Posts, and Director of Lands

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COFFEE CULTURE

By F. G. GALANG, *Horticulturist*

On its introduction into Europe coffee was looked upon as detrimental to morals partly because it was considered as a sort of intoxicant, and partly because it brought crowds of people together in coffee houses to talk scandal. The original name of the plant is said to have been derived from the word *"cabe,"* and the present name is a derivation from this word literally meaning that which takes away the appetite, while others believe that coffee was derived from Kaffa, where it was first grown. Now there is a coffee habit as there is an opium or tobacco habit. Most people think they cannot get along a day without coffee. At first a decoction of the berry husk was used; some drank an infusion of the pulp and coffee leaves for a beverage, and it was left to the Persians to invent the drink prepared from roasted beans.

Coffee has been in cultivation only as far back as the fifteenth century. In the Philippines it is said to have been first introduced by the Spanish missionaries during the eighteenth century. Its systematic cultivation commenced early in the nineteenth century, first in Laguna, then in Batangas and Cavite. Most of the coffee then was produced in these provinces though some was grown in Tayabas, Misamis, Camarines, and Cotabato. The best coffee was produced in Batangas and Mindanao, however.

In 1808 only a few plants were grown in Batangas province, and cultivation on a large scale did not start in Lipa and adjoining municipalities until 1859, while in 1889 disease broke out and destroyed the coffee plantations. In 1889 about two-thirds of the land in Lipa was planted to coffee, and the price rose to ₱25 per picul at one time. In Benguet coffee was first planted in 1875 by one Mr. Manuel Scheidugel, and in 1884 coffee was found growing wild in Nueva Vizcaya and its cultivation here was extended until it became one of the principal crops of the district.

The status of the coffee industry in the Philippines for the last 13 years is shown in the following table:

Year	Production	Importation	Exportation	Total consumption	
	Kilos	*Kilos*	*Kilos*	*Kilos*	*Per cent*
1915	694,900	792,684	565	1,487,019	4.87
1916	732,200	1,062,022	(a)	1,794,222	5.87
1917	594,600	1,294,920	1,393	1,888,127	6.18
1918	712,800	1,260,819	116	1,973,505	6.46
1919	717,200	892,156	(a)	1,609,356	5.27
1920	998,800	1,457,074	12	2,455,862	8.04
1921	1,062,300	1,458,637	(a)	2,520,937	8.25
1922	1,146,900	1,506,104	18	2,652,986	8.69
1923	1,155,700	1,853,857	615	3,008,942	9.82
1924	1,173,600	1,586,660	135	2,760,125	9.04
1925	1,178,200	1,452,995	(a)	2,631,195	8.61
1926	1,207,300	1,546,581	(b)	2,753,881	9.02
1927	1,209,800	1,779,495	96	2,989,199	9.79
Total	13,584,300	17,944,004	2,952	30,525,356	99.91

[a] None. [b] No report.

It is not gratifying to note that the annual importation of coffee into the Islands amounts to over a million pesos when as a matter of fact this importation could be either entirely stopped or greatly reduced. The coffee industry was a very lucrative one up to the year 1890, and until the year 1902, the Islands used to export coffee to the outside world, but this was stopped by the prevalence of diseases and pests that destroyed coffee in this country as well as in other countries in the tropics. Between 1854 and 1902, a total of 114,379,973 kilos of coffee valued at ₱33,084,858 was exported from the Philippines except in the years 1859, 1868 to 1872 and 1896 to 1897, when no exportations of coffee were made. Since then it has frequently been urged that it would be unprofitable to establish a coffee industry here because of the diseases and pests that attack it, because of the higher scale of wages here than in Java and other coffee-growing countries. Yet it is a remarkable fact that the coffee industry has managed to maintain itself in Hawaii where the wage scale is far higher than in the Islands or elsewhere in the tropics.

CLIMATE AND SOIL

There is no cause for anxiety if embarking in the coffee enterprise in the Philippines because of the favorable soil and climate conditions in many parts which are identical with those of the leading coffee-producing countries of the tropics. From what is known of the requirements of the various blight resistant coffees that are cultivated in Java, of the climate and soil in most parts of the Archipelago, it is reasonable to believe that

planted in those districts to which they are adapted and given the proper care, a number of coffees will grow and produce abundant crops. Coffee thrives best in a fairly deep soil, loose, friable, well drained and rich in vegetable matters and preferably of volcanic origin. Slopes along volcanic places are especially adapted to coffee plantations. Soils with chalk, marl and red clay texture are not suitable for this plant. Along the mountain slopes where most of the successful coffee plantations are found in Java, the soil is deep, friable, loamy, fine, rich, not sticky clay. In the coffee plantations in Hawaii the land is rolling, the soil deep and of volcanic origin, black or grayish to brownish, fertile and friable.

Coffee suffers severely from strong winds so wind-breaks should be provided against the direction of the prevailing winds when natural wind-breaks are absent. The best temperature for coffee is from 60 to 75° F and varying altitudes and rainfall are suitable according to the varieties or types of coffee.

The Arabian type is found to grow well at lower altitudes with a well-marked, short, dry season, but because of the coffee blight, *Hemileia vastatrix,* it should not be planted below 800 meters and does best up to 2,000 meters or more. In the Mountain Province below 1,000 meters elevation the Arabian coffee is attacked by the blight. Altitude alone therefore will not render this variety resistant to *Hemileia.* Soil and rainfall play important parts. It grows best on a rich, friable to even rather stiff loamy soil in a temperature of 60 to 70° F.

The Robusta type should be planted only in a rich, friable and loamy soil, and where there is a well distributed rainfall throughout the year, preferably from 2,000 to 2,500 millimeters. It requires an altitude of from 450 to 700 meters for its best development although it may be grown from sea level to an elevation of 1,000 meters.

The Liberian type grows at elevations from sea level to 700 meters. But the Liberian variety should not be grown above 350 meters. This type of coffee is drought-resistant and it may succeed in districts with a pronounced dry season and a rainfall of 1,200 millimeters. The yield will be greater, however, in places where there is a uniform distribution of rainfall. It thrives even on heavy clay soil.

The following tables show the rainfall at the Bangelan Coffee Experiment Station, Malang, Java, where the Robusta and the Liberian types are successfully grown; and at Kealakekna, the

Kona coffee district of Hawaii, where Arabian coffee is grown at a profit.

Rainfall at Bangelan, Java

Month	5-year average (1909-1913)		3-year average (1919-1921)		3-year average (1923-1925)		Average	
	Rainfall	Rainy days	Rainfall	Rainy days	Rainfall	Rainy days	Rainfall	Rainy days
	mm.		*mm.*		*mm.*		*mm.*	
January	470.62	27.8	350.83	22.6	316.33	21.0	379.29	23.8
February	396.98	23.8	328.33	18.6	263.33	20.0	329.54	30.8
March	331.62	26.0	398.66	18.0	336.33	26.6	355.53	23.5
April	313.34	19.4	250.33	14.6	233.66	15.6	265.77	16.5
May	175.92	15.4	115.16	8.0	83.33	5.6	124.47	9.6
June	109.48	12.4	80.33	6.3	59.33	4.0	83.04	7.5
July	81.18	10.0	33.33	3.3	96.33	6.3	70.28	6.5
August	31.40	6.0	68.00	6.3	.....	.....	49.70	6.1
September	43.90	8.4	76.00	6.3	1.66	0.3	40.52	5.0
October	249.24	18.6	126.66	7.0	163.66	6.3	179.85	10.6
November	286.44	20.6	293.66	19.0	251.33	13.6	277.14	17.7
December	376.40	22.4	401.33	20.3	315.00	13.6	364.24	18.8
Total	2,866.52	210.8	2,522.62	150.3	2,120.29	132.9	2,520.37	176.4

Rainfall at Kealakekna, Hawaii

(192 rainy days)

	mm.		*mm.*
January	84.0	August	174.0
February	87.2	September	188.5
March	94.5	October	147.7
April	112.0	November	86.0
May	161.0	December	100.5
June	161.7		
July	156.5	Total	1,373.7

The rainfall for the last ten years at the Lamao Experiment Station, Lamao, Bataan, where the Liberian, Abeocuta, Dybowskii, and the Excelsa varieties are grown quite successfully has been as follows in millimeters:

Rainfall at Lamao, Bataan

Month	1917	1918	1919	1920	1921
January	.....	.....	6.35	.....	.....
February	.....	5.08	.....	.....	.....
March	.....	34.29	.....	.....	.....
April	.....	73.66	.....	.....	.....
May	152.91	12.19	24.64	139.45	195.83
June	243.84	409.45	6.35	1,575.31	161.54
July	826.77	959.87	103.89	959.10	254.00
August	312.67	696.98	2,331.21	.....	1,409.70
September	252.98	449.07	295.15	289.56	208.28
October	217.42	387.86	249.68	218.44	66.55
November	125.98	.....	85.34	193.04	425.20
December	14.73	35.56	19.81	68.58	5.84
Total	2,147.30	3,064.01	3,122.42	3,443.48	2,726.94

Rainfall at Lamao, Bataan—Continued

Month	1922	1923	1924	1925	1926
January		9.14	34.04		7.11
February		63.50	16.76	35.56	
March		42.93	13.46	4.57	6.86
April	50.80	9.65	15.49	4.32	1.78
May	264.41	523.75	122.94	144.27	203.20
June	236.22	536.96	293.88	705.36	610.36
July	892.05	378.46	826.52	720.34	357.38
August	218.95	1,379.22	765.30	1,015.49	520.70
September	480.31	449.07	179.83	519.43	396.24
October	202.69	30.48	433.07	459.49	191.53
November	42.16	477.52	165.10	35.56	39.37
December	136.40	23.37	152.15	10.92	57.40
Total	2,523.99	3,924.05	3,017.54	3,655.31	2,391.93

At La Carlota Experiment Station, La Carlota, Occidental Negros, where the Robusta and Liberian types are quite successfully grown, the elevation is about 120 meters above sea level and the soil is of sandy loam, slightly sloping and analyzing as per the Bureau of Science records from the soil samples submitted by the Bureau of Agriculture, as follows:

Chemical analysis

Water-free basis

	Per cent		*Per cent*
Loss on ignition	9.070	Potash (K_2O)	0.983
Nitrogen (N_2)	0.262	Humus	1.910
Phosphoric anhydride (P_2O_5)	0.667	Acidity ($CaCO_3$)	0.024
Calcium (CaO)	4.390		

The rainfall at La Carlota is quite uniformly distributed and generally there is but a short dry season commencing in December and terminating in April. The rainfall and number of rainy days for ten years are as follows:

Rainfall at La Carlota, Occidental Negros

Year	Rainfall in millimeters	Rainy days	Year	Rainfall in millimeters	Rainy days
1916	2,956.05	192	1922	3,208.53	188
1917	3,890.90	218	1923	3,187.70	186
1918	2,612.64	190	1924	2,969.26	200
1919	2,732.28	171	1925	3,083.24	207
1920	3,923.79	168			
1921	2,968.50	190	Average	3,103.89	191

At Lipa, Batangas, where Arabian coffee was once an export crop, the altitude is about 304 meters above sea level. The land,

which is rolling and of a clay loam in texture, analyzes as follows:

Chemical analysis

Water-free basis

	Per cent		*Per cent*
Loss on ignition	10.370	Lime (CaO)	1.670
Nitrogen (N_2)	0.158	Potash (K_2O)	0.995
Phosphoric anhydride (P_2O_5)	0.419	Humus	1.245
		Acidity ($CaCO_3$)	0.011

Mechanical analysis

Water-free basis	Surface soil *Per cent*	Sub-soil *Per cent*
Coarse sand (1–0.5 mm.)	1.55	0.60
Medium sand (0.5–0.25 mm.)	5.60	6.15
Fine sand (0.25–0.10 mm.)	11.20	8.45
Very fine sand (0.10–0.05 mm.)	12.05	8.05
Silt (0.05–0.005 mm.)	50.15	43.80
Clay (0.003 mm.)	19.45	32.95
Total	100.00	100.00

It should be borne in mind that the rainfall in the Philippines is rather local. Furthermore, the effect of too little and of too much rain on the development of the coffee plants should be considered. In a markedly dry season the growth of the coffee is checked but this is usually followed by an excellent crop. On the other hand if the moisture is excessive there is a tendency for the coffee plant to produce many leaves and few berries, and if there is too much rain the flowers will rot and fall without setting fruits, and they are also apt not to be properly cross fertilized. However, coffee needs only a few hours of sunshine for the complete fertilization of its flowers. Heavy rainfall is not injurious to coffee provided the soil is well drained and it does not rain during the flowering period.

VARIETIES

The principal varieties of present importance are the Arabica, which includes the Porto Rican, Padang, Bourbon, Erecta, Columnaris, Maragogipe, San Ramon, Mocha, and Murta types; the Robusta, with its allied types, Congo, Uganda, Quillou, Canephora, Bukobensis, Sankurensis, and Laurensis; and the Liberica, with its Excelsa, Dybowskii, Abeocuta, Dewevrei, and Arnoldiana types. The varieties grown in the Philippines on plantations are the Arabian, the Robusta, the Liberian, and the Excelsa coffees. Each of these varieties, as previously men-

tioned, requires a certain altitude, temperature, kind of soil and amount of rainfall; and each is to a different degree resistant to various diseases and pests. The high prices which some varieties bring and the greater productivity of others are important considerations in the selection of the variety to be planted.

With a view to rehabilitating the coffee industry in the Philippines, a comparative trial of the foreign varieties of coffee, especially of the Robusta type, and the Excelsa, Dybowskii and Abeocuta of the Liberian type, which were introduced early in 1915 by the Bureau of Agriculture from Java, has been undertaken at the Lamao and La Carlota Experiment Stations and at the Lipa Demonstration Station. The results obtained from these varieties have awakened a lively interest in the people in Batangas, formerly a noted coffee province, and there has been a growing demand for them all, but especially for the Excelsa, and for knowledge relative to their culture, requirements and degree of resistance to diseases and pests.

The planting of Arabian coffee in places where it was grown before would result only in a disappointment due to the susceptibility of the variety to the coffee blight. As regards Liberian coffee, the Bureau of Agriculture planted this variety on two or more hectares on the Roxas Estate in Lipa, and while the cultivation of this field was abandoned long ago and the coffee trees became overgrown with native vegetation yet these plants served as the main sources for seeds for Batangas province, where this variety is now widely cultivated. Although bearing trees of Robusta coffee are reported from Lipa, Batangas; Basilan, Zamboanga and Lamao, Bataan yet this variety was not introduced into the Philippines to any extent prior to 1915.

The Arabian coffee (*Coffea arabica*) is an ever-green, delicate shrub and most sensitive, not only to *Hemileia,* nematode worms and other parasites, but to variations of heat, moisture, sunlight, etc. It is a native of Abyssinia. It grows to a height of 5.4 to 6.0 meters. The leaves are oblong-ovate, smooth, about 0.1524 meter long and 0.0635 meter wide. The flowers are in dense clusters in the axils of the leaves, with a 5-toothed calyx, a tubular parted corolla, 5 stamens and a single style, white and fragrant. The berry is fleshy and as it ripens it assumes a dark red color. Each berry contains 2 seeds imbedded in a whitish pulp and inclosed in a thin membranous parchment. Between each seed and the parchment is the silverskin. The seed is convex in form and of a soft semi-translucent, bluish,

or greenish color, hard and tough in texture. This type includes several species or varieties such as the Amarilla, Maragogipe, Leococarpa, Intermedia, Stuhlomanni, Humboltiana, Rachiformis, Augustifolia, and Stranimea coffees. The Arabian variety is the highest priced and most sought for coffee on account of its superior flavor, and because it comes into bearing in about 2 to 3 years.

The Robusta type includes several species and varieties, which are quite hard to differentiate but quite distinct both from the Arabian and the Liberian types. The Quillou, the Congo, the Robusta, the Uganda, and the Canephora are grouped under the Robusta type and considered the most important coffees belonging to this type.

The Robusta variety (*Coffea robusta*) originated in tropical Africa, and at present is considered the best commercial coffee in Java though it has not so good a flavor as the other coffees. The berries ripen more slowly at higher elevations, and the trees begin to yield in about three years below 300 meters. It is quite resistant to blight but very susceptible to the nematode worm. It has variable sized berries, which makes it difficult to pulp. This variety has proved to be an excellent temporary catch-crop for rubber in Java. It became a famous variety there because it is a heavy yielder, a regular bearer and comes true to type when planted from seeds. The tree is more or less umbrella-shaped, due to the fact that the branches are long and bend towards the ground. The leaves are wrinkled, dark green and not so thin as those of the Arabica, nor so thick as the leaves of the Liberian type. Ripe berries are blood-red in color, have a flat navel with thin pulp and are smaller than the Arabica. The silverskin is brownish and rough in appearance, and adheres closely to the bean, but it is easily removed by artificial drying. Records show that the Robusta coffee was first planted here in 1900 at Lipa, Batangas, and in 1909 at the Lamao Experiment Station, Lamao, Bataan and at Basilan, Zamboanga.

Congo coffee (*Coffea congensis*) is a native of Africa and closely allied to the Arabica and yet it is classed under the Robusta type. It is a blight-resistant coffee and requires the same soil and climatic conditions as the Robusta for its best development. Its young branches are pointed upward. The leaves are smooth, light green and with winged and white pulpy berries. The berries are flat like the Arabica, and borne on a longer pedicel than the true Robusta and the silverskin is brownish and the beans smaller. It begins to bear at the age of 3 years.

Liberian coffee grown at the Lamao Experiment Station, Lamao, Bataan

The Quillou variety (*Coffea quillou*) is of African origin and is closely related to the Robusta and only exhibits a very slight difference from the latter variety. The trees are more compact and with narrower leaves and shorter internodes than the Robusta. The old leaf is a little lighter green than the Robusta and when quite young it is brownish or rusty. The berry is bright red, not dark red and the silverskin is brown not greyish like Robusta and has a thinner husk. Furthermore, the bean is less rounded than the Robusta, being proportionally longer and in some cases rather pointed. It has a better flavor, is a heavy yielder, early maturing and has more uniform beans than the Robusta. The beans are yellowish in color while those of the Robusta are blue-green. It begins to yield in about 3 years. It is rather resistant to *Hemileia*. In Java the Quillou is marketed as Robusta, which it much resembles.

The Canephora coffee (*Coffea canephora*) is a native of Africa and its berry is like that of the Quillou, which is bright or vermilion red, never dark red or bluish when ripe; when very young the berry has a bronze color and is smaller than the Robusta berry. The silverskin adheres closely to the bean and is more uniformly brown in color than the Robusta. The leaf is not emarginate towards the stalk, like that of the Robusta, but gradually tapering and comparatively narrow. The borders of the leaf are not scalloped, as in many of the Robusta type, but flat. It produces its first crop at three years and thrives well under heavy shade, which makes it a good variety under rubber. It is a blight-resistant coffee.

The Uganda variety (*Coffea ugandae*) is of African origin with small, oval and scalloped leaves, smaller than those of the Robusta. The berry is of a light red color and on a rather long pedicel like that of the Arabica. It is more resistant to the blight than the Robusta variety. It begins to bear in 3 years.

The Liberian type includes the Liberian, the Excelsa, the Abeocuta and the Dybowskii coffees, which are considered the most important varieties under this group.

Liberian coffee (*Coffea liberica*) is indigenous to Liberia, West Africa. It has an upright growth, begins to bear in about 4 or 5 years and reaches a height of about 9 meters. The leaves are about twice as long as those of the Arabica. The tree bears white or slightly pink flowers. The berries are large, round and light yellow with fine stripes in dull red. The skin is thick and the pulp is somewhat bitter and not juicy. The parchment is more woody and darker in color than that of the Ara-

bica. Ripe berries do not fall to the ground as do the Arabica and they are borne singly and in small clusters rather than in densely crowded clusters like those of the Excelsa and the Robusta types. The bean is fairly plump with a concave face furrowed with a broadly open suture, of a greenish straw color and with clay-colored silverskin. It is quite resistant to the nematode worm, but no new plantations of this variety are being set out in Java, as it has also been found to be badly affected by the blight. As it is the strongest in taste and a fine flavored coffee it is in demand for blending with other varieties. The flowers and berries are the largest in size of all the coffee varieties grown. The tree is a robust and prolific bearer. This variety was first planted at San Jose, Batangas, in 1891, at San Miguel, Tarlac, in 1898, and at the Lamao Experiment Station, Lamao, Bataan, in 1907, as per available records.

The Excelsa coffee (*Coffea excelsa*) is likewise of African origin. It bears well and is of vigorous growth with very extraordinary sized leaves, oval and more rounded than the Liberian. It differs from the latter variety as to leaves, flowers, and berries. Different types of berries are produced from the trees planted at the Lamao Experiment Station, Lamao, Bataan, but all are of good quality. As the berries vary in size this gives trouble with the pulping machines. The berries are in thick clusters and smaller than the Liberian, and of solid color. They do not fall on ripening. The pulp is firmer than that of the Arabica. The silverskin is pale brownish and a considerable portion adheres to the bean, giving it a rough and uneven appearance unless dried artificially. The bean is straw-colored. The tree bears in about 4 to 5 years, and a full crop is obtained at the age of 7 to 8 years. It is very resistant to the attack of the nematode worm, and because of its resistance to the blight and to drought it is now becoming very popular in the Philippines at lower elevations and where the rainfall is not well distributed. It approaches the quality of the Arabian coffee both in flavor and aroma.

The Abeocuta (*Coffea abeocuta*) variety is a strain of the Liberian coffee. It is not much attacked by the coffee blight. It stands between the Liberian and the Excelsa coffee in vigor and is more susceptible to the blight than the Excelsa. Its foliage, fruit and manner of growth are similar to the Liberian. The berries are medium large and with thick pulp. The tree fruits at about the same age as the Excelsa. In quality of

fruits it equals Excelsa but gives a lower yield. It is worth trying in the Philippines because of its strong flavor and vigorous growth.

The Dybowskii variety (*Coffea dybowskii*) is of vigorous growth. It is very similar to the Excelsa with its longer internodes, larger leaves, and closely clustered berries. The leaves are large, oval and of heavy texture. The berries are large and with rather thick pulp.

The hybrids, Kawisari B and D, are becoming very popular varieties in Java because of their immunity to the blight and their excellent flavor. They are the natural hybrids of the Liberian and the Arabian coffees, and for this reason are not a pure strain, and are usually propagated by grafting. These two hybrids are said to stand unfavorable soil and climatic conditions, and are of vigorous growth, healthy and constant croppers. The berries when ripe do not fall so easily as do those of the Arabica. They do well under the same conditions as the Liberian and the Robusta types.

A hybrid between the Congensis and Uganda coffees has been recently developed in Java and is said to be a good yielder at the Bangelan Coffee Experiment Station, Malang, Java.

HYBRIDIZATION

The first variety of commercial importance was the Arabica and then came the Liberica, which variety is being replaced by the Robusta in Java and it may not be long before the hybrids, Kawisari B and D or some other strains of coffee, will take the place of the Robusta. Hence the importance of developing new varieties or strains of coffee to replace the old ones to assure the right planting materials for future plantings. Varieties that are reported to stand the blight at present may become susceptible to it after long and continuous cultivation in the same locality.

Hybridization in coffee takes place freely and large numbers of hybrids may be obtained without resort to the more tedious method of hand pollination. Bees and other insects are not absolutely essential for the fertilization of coffee flowers, for even when coffee flowers have been bagged to exclude insects, berries have been formed. It has been noticed, however, that in cases where insects, especially bees, were absent or few during the flowering time, the crop was small in proportion to the number of flowers.

Fertilization takes place just before the flower bud opens, when it will be found that the lobes of the stigma are just beneath the apex of the bud, and far out of reach of the anthers; and on its opening, the petals and anthers fall away from the stigma, which stands erect and protrudes far out from the corolla. Hand pollination of coffee is done in the same way as with other plants, viz., the male parts are removed to render the flower essentially female, which is done before the pollen matures; then the pollen taken from the male parent is applied and the cross-fertilized flowers bagged so as to exclude any foreign pollen which might be carried by insects or some other agency.

SELECTION AND PREPARATION OF SEED

The seeds for planting should be carefully selected and only the best, full grown and well shaped beans planted. For if poor seeds are planted low yielding trees are the result. In selecting seeds and budsticks a planter must bear in mind the following points:

1. Productiveness
2. Quality
3. Resistance to diseases and pests
4. General vigor
5. Adaptability to soil and climatic conditions
6. Season of crops

At the Bangelan Coffee Experiment Station, Malang, Java, the following procedures are followed in segregating the best yielding trees in order to eliminate all possible variations:

1. From 100 to 200 seedlings are raised from one mother tree and these are set out in a trial plot.

2. From the 100 or 200 plants only 10 to 20 trees of healthy good yielders are selected. The yields, characteristics and behavior of the selected plants are recorded for 3 or 4 years.

3. Again from the 10 to 20 trees the five best plants are selected. Then budwoods for grafting are taken from the chosen trees.

4. From 16 to 20 grafted plants each of the five selected trees are established in a museum garden as they call it. The records of production and behavior are kept as usual.

5. From the grafted trees they next select from 40 to 50 trees from which they draw plant materials for propagation, and plant these in a multiplication plot.

6. Trees are selected from the multiplication plot and these are set out to the hectare-garden as they call it. All of the trees are grafted, and from the resulting best plants from this grove they make or draw their materials for the plantations.

The following shows the yields in kilos of clean coffee obtained from the different strains of a hybrid coffee and some of the best yielding Robusta coffee at the Bangelan Coffee Experiment Station, Malang, Java:

Yields of No. 124.01 Robusta x Uganda coffee

(Two generations of grafted trees)

Tree No.	Yearly yields in kilos of clean coffee							
	1918	1919	1920	1921	1922	1923	6 years average	4 normal years average
1	2.254	0.950	0.167	2.334	3.468	2.088	1.877	2.536
2	3.212	1.065	2.153	2.490	3.607	1.539	2.344	2.712
3	1.352	0.675	0.140	1.969	2.010	1.685	1.305	1.504
4	2.131	0.631	0.851	3.350	3.510	1.187	1.943	2.544
5	1.334	0.741	1.222	2.864	1.601	1.208	1.495	1.727
6	0.931	0.430	0.731	2.951	1.597	0.694	1.222	1.543
7	1.471	0.196	0.488	2.322	6.836	0.413	1.954	2.760
8	3.874	0.770	1.482	1.156	1.032	0.989	1.550	1.763
9	1.796	0.528	0.371	1.853	2.404	0.649	1.267	1.928
10	1.573	0.346	1.958	3.036	4.718	1.787	2.236	2.778
11	0.944	0.322	0.397	1.560	1.687	1.667	1.096	1.464
12	2.472	0.287	0.887	1.869	3.308	0.623	1.574	2.068
13	2.587	0.640	0.702	2.008	2.732	1.221	1.648	2.187

The low yields reported in 1919 and 1920 were due to the eruption of Mt. Klut, when many of the trees wilted, and to the appearance of the coffee beetle in 1920, which is now a dangerous pest in Java.

Coffee No. 124.01 is a hybrid between the Robusta and the Uganda coffee seedling No. 1, which is a good tree from seedling plantation, and No. 124 is the mother tree at the Bangelan Coffee Experiment Station, Malang, Java. This hybrid produces uniform beans that are easy to pulp and hull. Not all the mother plants possess good grafting qualities—some are poor while others are good and take easy when grafted with other coffee plants, it is said. This particular hybrid, however, has good grafting qualities.

Yields per tree in kilos of clean coffee of the best yielding Robusta coffee in Java

Mother tree	Year planted	Yearly yields in kilos of clean coffee						
		1913	1914	1915	1916	1917	1918	Average
Robusta–78	.....	.....	.....	2.689	5.017	3.035	5.553	4.074
Robusta–124.01	1908	.....	.....	2.991	9.949	0.822	2.530	4.074
Robusta–83	1904	.....	3.846	2.995	6.173	2.727	6.020	4.342
Robusta–105	1901	4.230	6.279	4.238	6.958	7.192	5.218	5.686

The highest yielding of the Liberian and Excelsa coffees at the Lamao Experiment Station, Lamao, Bataan, are tabulated as follows:

Highest yielding Excelsa coffee

Tree No.	Yearly yields in kilos of clean coffee									
	1919	1920	1921	1922	1923	1924	1925	1926	1927	Average
FIELD–E										
R1T1	0.02	.....	1.21	4.07	1.59	5.15	5.04	6.30	1.32	3.09
R1T6	0.05	.....	1.16	1.39	2.93	1.56	4.64	2.89	1.42	2.01
R3T5	.....	.....	4.00	1.10	2.37	.....	3.80	2.45	2.41	2.69
R4T1	.....	.....	0.13	2.32	2.59	6.57	1.96	4.02	.....	2.93
R4T4	.....	.....	2.85	3.30	4.21	1.14	3.10	1.57	1.80	2.56
R5T2	0.01	0.63	1.62	4.19	1.00	2.08	3.67	5.42	0.80	2.16
R7T2	.....	.....	1.99	3.13	1.12	4.47	0.84	8.57	0.20	2.90
R8T6	0.08	.....	0.53	4.52	.....	0.18	5.84	3.67	6.12	2.99
R8T8	0.12	0.75	1.56	2.96	0.69	5.00	2.72	4.02	.....	2.23
R9T3	.....	0.05	1.57	3.40	6.67	0.60	3.12	4.37	.....	2.82
R9T6	0.04	.....	1.38	1.77	5.38	5.01	0.73	3.15	3.02	2.56
R12T2	.....	0.17	3.74	2.10	5.30	2.11	0.87	5.07	.....	2.76
R12T3	0.14	0.29	0.88	3.11	1.74	2.29	7.80	0.52	4.00	2.31
R12T8	.....	0.04	0.70	1.16	2.59	4.90	.....	8.05	.....	2.91
R13T1	.....	0.33	2.90	3.78	1.62	3.50	1.00	6.47	.....	2.80
R13T2	.....	0.04	1.25	1.91	2.64	1.92	2.16	4.50	.....	2.05
R15T6	0.10	0.30	1.27	2.55	1.73	6.80	1.84	6.05	.....	2.58
R16T8	.....	0.65	0.44	1.80	0.16	10.35	.....	2.27	.....	2.56

Highest yielding Liberian coffee

Tree No.	Yearly yields in kilos of clean coffee						
	1922	1923	1924	1925	1926	1927	Average
FIELD–E							
R1T3	0.67	0.50	3.58	1.98	6.40	2.69	2.64
R2T6	0.28	1.33	3.44	2.24	4.16	2.22	2.28
R2T8	.....	.....	0.81	3.13	2.72	1.97	2.23
R3T8	.....	.....	0.89	2.88	3.45	4.00	2.81
R6T2	1.89	0.63	3.44	3.02	4.48	.....	2.69
FIELD–P							
R4T10	.....	.....	0.40	1.53	5.28	.....	2.40
R4T11	.....	.....	1.63	1.88	2.56	.....	2.02
R4T12	.....	.....	4.00	2.24	3.84	.....	3.36

In field "E" the Liberian coffees No. R1T3 and R2T6 and the Excelsa coffees No. R1T1, R1T6, R5T2, R9T6 and R12T3 were regular bearers.

In Java, seeds for planting are never allowed to pass through the pulping machine but instead the husks are bitten by women, then the beans washed in fresh water with sand or ashes to remove the slime, as if this were not removed the seeds might start to ferment. The seeds are then air-dried under shade. Sometimes they are dusted with powdered charcoal to hasten their drying before any fungus infection. At the Lamao Ex-

periment Station, Lamao, Bataan, the husks of the seeds for planting are removed by breaking them between two boards nailed together at one end, which method is believed more convenient than that practised in Java.

Coffee seeds if kept in a dry atmosphere very quickly lose their germinating power, due probably to the evaporation of part of their moisture content. Therefore seeds that can not be sown at once should be preserved in moist charcoal, moss or sand placed in air-tight containers. Moist moss is the best as found from the tests conducted at the Lamao Experiment Station, where the seeds have kept viable for 15 months. The highest percentage of germination was obtained during the tenth monthly test—94 per cent; and 60 per cent germination in the last or the sixteenth test.

PROPAGATION

Coffee is propagated by seed and by budding or grafting. The first method is the commonest, but in Java grafting is now being employed more extensively in starting new plantations and in rejuvenating the old ones.

The land to be selected for seed bed and nursery should be well drained, having a rich, loamy soil. With ordinary rainfall a light bamboo frame should be erected above the nursery about 2.5 meters high, and covered with split bamboo, cogon, or other grasses or palm leaves to provide half shade. If the rains are so heavy that they are likely to wash out the coffee seeds, they should be sown under a rain-proof shelter. The land should be spaded thoroughly to a depth of about 30 centimeters, and all stones, roots, and trash removed. From 1 to 1.5 meters is a convenient width for seed and plant beds. The beds should be about 10 centimeters or so higher than the general level of the ground because of the danger from flooding during heavy rains.

Provided that the seedlings can be promptly transplanted to the nursery bed after germination, the coffee seeds may be broadcasted at the rate of 2,000 to 2,500 seeds to the square meter; but if the transplanting cannot be promptly attended to, it is best to spread the seeds over an area twice as large in order to produce strong plants. The seeds should be covered with not more than one centimeter of earth, and then watered thoroughly. Unless the rains provide sufficient moisture the seed bed should

be well watered from time to time, whenever the soil appears dry. Frequent sprinklings, light enough for the water not to penetrate more than a few millimeters below the surface of the soil, are harmful rather than beneficial both in the seed bed and in the nursery, in that they encourage a shallow root system.

As soon as the first pair of leaves are fully expanded the seedlings should be transplanted to the nursery beds, which should be prepared like the seed beds. If the land is poor it is well to spade in a liberal quantity of well-decayed manure or compost. The plants should be taken up carefully, the injured tap roots nipped off before transplanting and then transplanted with the aid of a pointed stick or small dibber, spacing them from 15 to 20 centimeters apart each way. In doing this, great care should be exercised to make the holes sufficiently wide and deep so that the roots are pointed downward, and not doubled up in the hole; that the soil is well packed around them, and that the plants are not set out deeper than they grew in the seed bed. More plants should never be removed at one time from the seed bed than can be conveniently transplanted before they show signs of wilting, and the plants dug up should not be left exposed until the roots dry out. The plants should be thoroughly watered before and after transplanting, and the beds kept free from weeds and watered as often as necessary.

Considerable variation has been found in coffee grown from seed, and it is becoming generally recognized that budding and grafting from the individual superior trees must be resorted to in order to obtain the best results. In the case of the hybrids this operation is in fact absolutely necessary, since all the hybrids that have fruited so far in Java failed to come true to seed and produced an exceedingly variable progeny, which in most cases was inferior to the hybrid parent.

Budding.—First make a vertical cut through the bark up to the cambium layer of the stock, and a horizontal one at the bottom of it to form an inverted T. Open the cut or split bark with the blade of the budding knife when the bud is to be inserted. Cut two to four centimeters of the bud from the budstick by means of a sharp knife, leaving only a very small bit of wood under the bud for its protection. The bud should be cut clean with no broken tissues, and inserted immediately in-

side the opened bark of the stock. It should be pushed upwards in order that no water may enter the cut. After the bud is inserted the whole wound should be wrapped in waxed cloth or tape sufficiently tight to bring the bud in touch with the cambium layer, but not too loosely or too tightly, lest the growth be adversely affected, or as in fact often happens, prevented entirely. The wound should be wrapped up to exclude the possibility of the injurious effects of dirt, moisture and air.

The buds are to be set at least 6 inches above the ground in order to prevent the stem from growing crooked and wild sprouts from appearing, to insure a strong stand, to enable the plant to withstand any disease which might affect the roots; and also to counteract, to a certain extent, the evils of too deep planting, when the trees have been set out in orchard form.

After 12 to 15 days from the date of the insertion of the buds, they may be examined to see if they have taken, or callused. If so, the wrapping should be carefully unwound until below the bud and an inspection made of each bud. The wrapper should not be allowed to remain too long around the buds, as there is a possibility of them getting overgrown by the bark of the stock, and then the natural attempt of the young growth to push out will be frustrated. When the bud has started to grow the stock may be half cut at a height of 6 inches or so and bent downward to induce the growth of the bud; and when the young bud is well developed into a young tree the top of the stock can be separated entirely by cutting close to the angle formed in the union between the stock and the scion. All wild sprouts, or what are oftentimes called water sprouts, should be removed as fast as they appear in order to facilitate the rapid development of the newly budded plants.

Cleft grafting.—Cleft grafting may be resorted to when the stock plant has developed to a buddable size or in the top-worked tree at once. The operation is performed as follows:

After the entire top is removed split the stock downward with a sharp knife or other suitable implement. The split should be neither too deep nor too shallow, but just deep enough for the cut part of the scion or a little more, and this can be held open by allowing the wedge portion of the knife or other grafting tool to remain in the cut portion of the stock. The scion is then cut at the base in a wedge shape. The cut should be made nar-

rower toward the base similar to the "bamboo tongue" of the clarinet. The scion is then inserted into the cut portion of the stock with the thin portion toward the inside of the cleft, but care should be taken that the cambium layers of the stock and the scion should be in contact with each other. One or more scions can be inserted in the top-worked tree. The wounded portions of the stock should be sealed with grafting wax after the inserted scion and the stock have been wound together with a tape, raffia or any other suitable material. In Java they use raffia fiber in tying the grafts after two pieces of bamboo have been placed on both sides of the grafts for their protection, and no wax is employed. The tip portion of the scion should be waxed. Delicate scions like coffee should be covered with manila paper or some other kinds of paper or with light cardboard so as to form a loose cylinder around the union extending a little above the tip of the scion. This should then be filled with moist moss or sawdust to prevent drying from the excessive heat of the sun. Banana petiole is also very serviceable in case no moss is available. In Java with newly grafted plants, the scions are covered with glass tubes for their protection from heat and moisture. Any of these coverings can be removed as soon as the graft heals, which will be in about 12 to 15 days.

Scions.—Only terminal branches should be used for scions in budding or grafting the coffee plant, for if budded or grafted with a horizontal scion the resulting plant always develops into a low spreading bush and never produces vertical growth. In budding and grafting, too, success can only be attained by employing non-petioled budwood. By non-petioled budwood is meant a scion where the leaves have dropped off previously or naturally. In order to induce the plant to produce more vertical branches it is necessary to cut off some of its horizontal branches.

Stock.—The stock plant should be ready for budding and grafting when it reaches the size of a lead pencil, provided a small budstick with a small bud is cut for insertion. One-half inch in size is the best for stock. The stock plants should be raised from selected seeds. At the Bangelan Coffee Experiment Station a hybrid coffee, No. 124.01, between the Robusta and the Uganda, has been found to be a good stock because of its

vigorous growth. Other results of their stock test are tabulated as follows:

Stock test at the Bangelan Coffee Experiment Station, Malang, Java

Scion	Stock	Year planted	Yield per hectare in kilos of clean coffee					
			1913	1914	1915	1916	1917	1918
Robusta No. 105	Seedling	1909	625.1	219.1	772.1	992.6	1,003.1	158.8
Do	do	1912	.....	.....	.....	1,234.1	1,405.6	592.9
Do	do	1913	.....	.....	370.3	1,309.4	782.6	1,149.4
Do	do	1914	.....	.....	.....	268.8	1,050.5	1,086.5
Do	Excelsa	1917	.....	.....	.....	.....	.....	.....
Do	do	1918	.....	.....	.....	.....	.....	.....
Do	do	1919	.....	.....	.....	.....	.....	.....
Do	Uganda	1919	.....	.....	.....	.....	.....	.....
Robusta No. 83	Excelsa	1907	.....	.....	.....	.....	.....	.....
Do	do	1908	.....	.....	.....	.....	.....	.....
Do	do	1914	.....	.....	.....	.....	.....	.....
Do	do	1919	.....	.....	.....	.....	.....	.....
Do	Robusta	.....	.....	.....	.....	.....	.....	.....
Robusta-124.01	Seedling	1917	.....	.....	.....	.....	.....	.....
Do	Excelsa	1917	.....	.....	.....	.....	.....	.....
Do	Canephora	1916	.....	.....	.....	.....	.....	.....
Robusta No. 78	Seedling	1915	.....	.....	.....	.....	.....	196.0
Do	Excelsa	1919	.....	.....	.....	.....	.....	.....
Do	Laurentii	1915	.....	.....	.....	.....	.....	.....

Scion	Stock	Year planted	Yield per hectare in kilos of clean coffee					
			1919	1920	1921	1922	1923	Average
Robusta No. 105	Seedling	1909	347.2	125.3	2,179.1	711.2	515.9	749.9
Do	do	1912	442.4	64.4	1,614.9	922.6	529.2	850.8
Do	do	1913	7.4	14.4	474.3	616.7	402.5	569.7
Do	do	1914	121.6	73.5	850.9	802.6	606.3	607.6
Do	Excelsa	1917	.....	.....	0.7	784.0	100.1	294.9
Do	do	1918	.....	.....	57.4	677.6	156.1	297.0
Do	do	1919	.....	.....	.....	105.7	293.7	199.7
Do	Uganda	1919	.....	.....	51.1	395.5	256.2	234.3
Robusta No. 83	Excelsa	1907	.....	.....	243.6	508.2	183.4	311.7
Do	do	1908	.....	.....	1,566.6	636.3	330.4	844.4
Do	do	1914	.....	.....	756.6	853.3	478.0	695.9
Do	do	1919	.....	.....	.....	324.1	457.1	390.6
Do	Robusta	.....	.....	.....	448.0	288.4	183.4	306.6
Robusta-124.01	Seedling	1917	73.5	57.4	282.8	621.6	149.8	237.0
Do	Excelsa	1917	.....	.....	207.9	845.6	291.2	448.2
Do	Canephora	1916	.....	207.9	1,859.2	970.9	674.1	928.0
Robusta No. 78	Seedling	1915	88.2	80.5	1,259.3	1,694.7	886.9	700.9
Do	Excelsa	1919	.....	.....	.....	175.7	319.9	247.8
Do	Laurentii	1915	.....	43.4	280.7	690.9	634.9	412.5

Tape.—The tape for tying budded or grafted plants is prepared by using cotton cloth that tears easily. This should be torn into pieces about 25 centimeters wide and the strip of cloth wound tightly around a stick about the size of a lead pencil until about three centimeters in diameter; for if the rolls are larger than this the melted wax would with difficulty penetrate through the cloth. To prevent the unwinding of the rolled cloth it should be tied at both ends with string. These rolls should be kept submerged in the melted wax until completely satur-

ated, or say from 20 to 30 minutes. The best test of course is to wait until they sink. The wax is prepared by melting together equal weights of beeswax and resin in an empty biscuit can, or an iron pot if obtainable. It is not necessary to boil the wax and resin. Some people prefer to use resin, lard and beeswax, but lard is not at all necessary, since a good tape can be made as described above. If resin is not to be had, wax can be made with beeswax and some of the best paraffin candles, melted together as in the former case. After all these processes have been gone through, the tape is ready for use. It is only necessary to tear off the strips desired when budding or grafting.

SELECTION, CLEARING, PREPARATION AND PLANTING OF THE LAND

Selection of land.—In selecting a place for coffee the points to be considered are as follows:

1. Elevation
2. Rainfall
3. Temperature
4. Appearance and character of the soil and subsoil (chemical and physical condition)
5. Area: virgin or used for other crops previously
6. Drainage
7. Water availability
8. Character of the present and former vegetation
9. Exposure to sun and wind
10. Transportation facilities

Clearing and preparation of land.—On land overgrown with trees and shrubs the vegetation should be cut and burned during the driest period of the year, and the small stumps grubbed and burned together with the remaining logs. After this is done the land is ready for staking and planting, and terracing if the latter is necessary. Cogon land must be plowed and cross-plowed and planted to legumes a year in advance of the planting of the coffee in order to destroy the cogon and improve the soil. By this method, the plantation can be cultivated by animals and the cost of weeding is greatly lessened or reduced to the minimum. The holes are dug from 80 to 100 centimeters deep and 40 to 60 centimeters in diameter, the size of the holes depending of course upon the character of the soil, and the size of the plants to be transplanted.

Planting.—Small seedlings having 5 to 6 pairs of leaves can be transplanted with or without a ball of earth with equally good

results, but if larger seedlings are to be transplanted it is advisable to provide each with a ball of earth in order to prevent a set-back of the plants, due to disturbance of the roots. About one-half of the foliage should be cut, and a trench dug at the end of the nursery bed, with a depth of about 20 centimeters or more, depending upon the development of the roots. Then a thin, sharp bolo or spade should be passed through the soil, underneath and around the plants, neatly severing all straggling roots and leaving the plant in the center of an oblong ball of earth. If the soil is so loose that it falls away from the roots when the plant is removed from the nursery, great care should be taken not to allow the roots to dry out; and to set out the plant so that the roots will not be matted together in the center of the hole, but spread out in their natural position. The holes should be filed only with surface soil. In the course of planting, the soil should be worked in, and firmly packed about the roots, and the plants should be set out in the field at the same depth as in the nursery. Due care should be taken not to break the soil. Transplanting should be done preferably at the beginning of the rainy season to enable the seedlings to become rooted before the dry season. Young plants should on no account be transplanted during the dry weather unless irrigated, as a few days' hot sun will be fatal to them.

The distance from each other at which the plants are to be set out should be given careful consideration, as, if too close, the plants would be crowded, and the lower branches, deprived of sun, will shed their leaves and fall; and if the distance is greater, the shade of the plants would not be sufficient to decrease soil erosion and evaporation of moisture and there would be a waste of land. The different coffee varieties should be planted at distances as follows, according to more or less favorable conditions for their development:

Variety	Distance	Number of plants per hectare
	meters	
Abeocuta	3.5 × 4.0	714
Arabian	2.5 × 3.0	1,333
Canephora	2.5 × 3.0	1,333
Congo	2.5 × 3.0	1,333
Excelsa	4.0 × 4.5	555
Dybowskii	4.0 × 4.5	555
Liberian	3.5 × 4.0	714
Quillou	3.0 × 3.5	952
Robusta	3.0 × 3.5	952
Uganda	2.5 × 3.0	1,333

SHADE

Coffee is a shallow-rooted plant with most of the lateral roots feeding or absorbing plant foods near the surface of the ground though with the tap root penetrating fairly deep into the soil; hence the necessity of growing coffee under shade at certain elevations. The shade tree tends to keep the moisture and supply humus in the soil when their leaves drop off. In Ceylon and Indo-China coffee in many cases is planted without shade. The amount of shade to be provided in a coffee plantation depends upon the altitude; and then again, less shade is needed where the sky is frequently overcast than where it is clear. As a rule coffee is shaded most heavily at the lowest elevation where it is grown, the need for shade decreasing with the rise in altitude. Opinions vary as to the best and most suitable trees for coffee shade. A particularly good shade in one locality may not prove so in another district. Trees that do not grow so large, having a maximum spread of branches to shade a large area, with fine leaves and not deciduous are preferable for coffee shade wherever they grow. Besides, they should be sub-soil feeders and capable of enriching the soil, not susceptible to diseases and pests attacking the coffee; capable of standing against strong winds, quick-growing and long-lived plants, and with a big leaf fall and suitable to the soil and climatic conditions of the place.

In Java, ipil-ipil, *Leucaena glauca,* dapdap, *Erythrina lithosperma,* and acacia, *Pithecolobium saman,* have been found to be the best plants for shade, in the order named. In other countries, the guama, *Inga vera,* and *Inga laurina,* the silk oak, *Grevillea robusta,* the ratamara, *Albizzia moluccana,* the matadiya, *Adenanthera pavonina,* and the bukare, *Erythrina micropteryx,* have been found serviceable. While it seems probable that the ipil-ipil will be equally good for coffee shade in the Philippines as in Java judging by the results obtained at the Lamao Experiment Station, Lamao, Bataan, still there may be exceptions to this rule. In Bukidnon and Basilan, Mindanao, for instance, the dapdap appears to be better than the ipil-ipil; in Lanao, Mindanao, the silk oak and the dapdap appear to be desirable, while in Batangas it is the madre-cacao, *Gliricidia maculata.*

In a limited way fruit trees, such as the soursop (guanabano), coconut, custard apple (anonas), breadfruit, avocado, etc., may also be used as shade trees for coffee.

A field planted to Excelsa coffee, Lamao Experiment Station, Lamao, Bataan

The easiest way of setting out ipil-ipil for shade trees is to make cuttings from 2 to 8 centimeters in diameter, one or more meters long, from the tops of old ipil-ipil trees, of well-matured growth, and insert them in holes made by a crowbar, packing the soil well around them so that they remain firm in the ground. About 85 per cent of the cuttings may be expected to grow. Dapdap and acacia cuttings may be treated in the same way as the ipil-ipil but the cuttings should be not less than 5 centimeters in diameter.

If the shade trees are propagated from seeds, prepare a seed bed, sow and cover the seeds thinly with fine soil, in rows from 20 to 25 centimeters apart, at the same time the coffee seeds are sown, or shortly thereafter. When the plants are needed for planting out cut them back to a height of one meter and transplant with the aid of a crowbar as already described.

Shade trees should be planted in advance so as to provide the proper shade at the proper time. If no such shade trees have been planted far in advance, and the permanent shade trees are not large enough to provide sufficient shade, a temporary shade shoud be planted at the same time when setting out the coffee seedlings in the field. Ipil-ipil, dapdap, or some other quick-growing plants, like the cadios, *Cajanus indicus,* the castor bean, *Ricinus communis,* and *Tephrosia candida,* which are easily eradicated and not likely to become weeds, except perhaps the ipil-ipil, all produce heavy growths of leaves for mulch and make excellent temporary shade for coffee. Ipil-ipil and dapdap should be planted alternately with the coffee plants when used as temporary shade, and a few seeds of cadios, castor bean, or *Tephrosia* should be sown or dropped in holes on both sides of each coffee plant along the rows, say a foot from the coffee. This will provide enough temporary shade until the permanent ones are well established.

The papaya makes a good temporary shade plant, but bananas being voracious feeders should not be used for this purpose. As the growth of coffee and shade progresses and the shade becomes excessive, the temporary shade plants should gradually be thinned out until finally only the permanent shade trees remain.

Trees for shade should be planted with the coffee plants as indicated in the following diagram:

Diagram of the field

b		*d*		*b*		*d*		*b*		*d*	
	a		*a*		*a*		*a*		*a*		
c		*b*		*c*		*b*		*c*		*b*	
	a		*a*		*a*		*a*		*a*		
b		*d*		*b*		*d*		*b*		*d*	
	a		*a*		*a*		*a*		*a*		
c		*b*		*c*		*b*		*c*		*b*	
	a		*a*		*a*		*a*		*a*		
b		*d*		*b*		*d*		*b*		*d*	
	a		*a*		*a*		*a*		*a*		
c		*b*		*c*		*b*		*c*		*b*	

a—represents the coffee plants.

b—represents the shade trees to be thinned out after three years depending of course upon their development.

c—represents the shade trees to the thinned out after five years according to their development.

d—represents the shade trees left for permanent shade.

It is always advisable to plant shade trees rather closely and then to gradually cut away first the surplus branches, then the trees as indicated in the above diagram in order to provide a reasonable shade for the coffee plants for their best development. If the permanent shade trees are allowed to develop too thick and with too heavy branches the coffee plants will grow tall with less branches and with longer internodes, and they will bear few berries, for too much or too little shade means reduced crop. And dampness also favors the development of fungi. After the elimination of all the unnecessary shade trees, the branches of the permanent ones should be pruned off whenever necessary. Pruning should be done on every other row.

CULTIVATION

The land should at all times be kept free from weeds either with cultivators or by hand-hoeing. On level and well-cleared land, cultivation for the first few years should be performed by animal-drawn and shallow cultivators, supplemented by hand-hoeing. In the hilly plantations, weeding should be done by hand. In hand-weeding soil mulch should always be established at least around the trees. The weeds should be left in the field for mulching.

Cultivation should be done preferably for a few days after the rains so as to conserve as much moisture as possible, which

would otherwise be lost by evaporation. Care should be taken so as not to injure the roots and branches while cultivating the open spaces between the coffee plants. When the coffee and shade plants are fully developed only an occasional hoeing is necessary, and anyway it would then be difficult to cultivate the plantation by animal-drawn cultivators without injuring the roots of the plants. At this time the dried leaves of the shade trees will help to maintain the soil tilth and mulch.

COVER CROPPING

Except when the land is exceptionally rich, it will be found advantageous to plant the vacant spaces between the coffee to some legumes for the first four years or until the land is well shaded by the coffee and the shade trees. Cover cropping will minimize the cost of weeding, prevent soil erosion, and the rapid evaporation of soil moisture; and if leguminous crops are planted it will enrich the soil. Cowpeas, mungos, peanuts, soy beans, Lyon beans, patani, marutong, indigo, *Crotalaria, Tephrosia, Calopogonium, Centrosema, Pueraria, Vigna oligosperma,* etc., are some of the leguminous crops that are worth trying.

In Java ipil-ipil is planted on the edges and exposed places of the plantation, and in some cases on steep land ipil-ipil seeds are sown in a semi-circular form in front of the coffee tree toward the bottom of the hill to prevent soil wash, and the ipil-ipil is continuously cut down to not more than 2 feet high. All the cut and dead branches are buried in the ground for green manuring.

TOPPING AND PRUNING

If coffee trees are allowed to grow tall without topping, the harvesting and the treatment for diseases and pests will be very difficult, and they are also very liable to be blown down by strong winds. Furthermore, untopped trees have the peculiar habit of growing their branches near the ground and at the top, leaving the middle bare or nearly so, which decreases the productivity of the plant. Top the trees when they are from 2.5 to 3.5 meters high—depending upon the variety—and keep them at this height and allow no more than three stems to sprout from the ground by removing all superfluous suckers. This is to be done while the sprouts are still young for at this stage they are still easily broken. All wild or water sprouts should be removed immediately so that long and spreading branches may be produced and the trees be more fruitful. Unpruned, neglected trees can not possibly yield a very profitable crop

and it is almost impossible to restore them at once. To induce the growth of more lateral branches, topping should be performed while the plant is still young or when it has made a growth of about a meter high.

Pruning in order to be of benefit should be done immediately after harvesting the crop and should be finished before the flowering season. In pruning clean cuts should always be made so that healing may take place at once, and all wounds should be painted with white lead or coal tar after the pruning has been performed to prevent the invasion of insects and fungi.

DRAINAGE AND IRRIGATION

Where the land slopes and the texture of the soil is of such a nature that it is easily washed away by rains terracing should be done. Trees in such areas will suffer from diseases and the yield fall off considerably. The terraces should follow the contour of the land, and should be so arranged as to hold the rain water and prevent soil wash. According to the slope of the land the terrace may be made wide enough for planting one or two rows of coffee plants, interspaced with shade trees according to the need. In terracing the planting of cover crops and grasses on the slopes other than cogon should be undertaken to prevent the rapid washing of the terraces. On level land building contour drains is very effective in preventing soil wash. Another object in constructing ditches for draining off the extra water is to permit just enough water to penetrate through the soil and to provide proper aëration of the soil. Lack of drains has been the cause of the rapid decline of many plantations in the Islands, especially coconut plantations. The main drains should be dug sufficiently wide and deep to carry off land surplus water, and laid in the direction of the natural flow of the surface water and at a suitable distance apart. The lateral drains should follow the contour of the land and should contain pits here and there to catch the surface soil that may be carried down by the water. The drains should be regularly cleared.

In Java and Sumatra soil-pitting or catch drains are constructed on undulating or hilly lands to prevent soil erosion and to hold back the rain water. A catch drain of 6 x 2 x 1½ feet is dug between the rows or where the water accumulates during the early stage of planting or even before planting.

No irrigation is necessary if the plantation is to be located where the soil and climatic conditions are proper for the best

development of the coffee variety to be planted. However, in a district where there is a prolonged dry season, irrigation becomes indispensable for the coffee plant in order to prolong its life. The Indian Scientific Agriculturist (No. 6, Volume 3, June, 1922) says as follows: "The minimum of rain for bringing out coffee blossoms wholly at one time is one inch. Of course, it does not matter if it should be 25 per cent less if the season is well advanced, and the buds consequently forward. In exceptional cases handsome crops have been known to result from precipitation of no more than 30 to 40 per cent."

In the irrigation test conducted at the Lamao Experiment Station in which Excelsa and Liberian varieties were irrigated twice a month during the dry season at the rate of 10, 20, 30, 40, and 50 gallons of water per tree in a basin system, it was found that the amount of water necessary depended to a large extent on the intensity and length of the dry season and partly to the drought resistance of the variety. The Excelsa resisted the drought better than the Liberian variety during the test. The results obtained from the irrigation test were as follows:

Yield of irrigated versus non-irrigated coffee

Variety	Yield of clean coffee per tree			
	1924	1925	1926	Average
	Kilos	*Kilos*	*Kilos*	*Kilos*
Excelsa (irrigated)	2.073	1.746	2.042	1.953
Excelsa (non-irrigated)	1.621	3.053	1.735	2.136
Liberian (irrigated)	2.142	0.770	2.144	1.685
Liberian (non-irrigated)	1.532	1.806	2.453	1.930

The average yield of the irrigated Excelsa and Liberian coffee as given in this table was not materially affected by the irrigation water, yet in general the physical condition of the irrigated trees was improved greatly compared with that of the non-irrigated trees. This was manifested by the yellowing and slight wilting of the leaves and the stunting of the non-irrigated trees during the dry season, which conditions did not exist among the irrigated trees.

Flowering and the formation of the berries of coffee at the Lamao Experiment Station take place when the coffee trees are still in excellent condition as there is yet sufficient soil moisture for the need of the plants. And as the irrigation water is applied only during the hottest part of the year—March and April—then naturally very little benefit is derived from it by the coffee plants in their production of berries.

MANURING

In the Agricultural News (No. 514, Volume 21, January 7, 1922), there is published an account as to the annual requirements of 1,000 coffee plants at different ages for nitrogen, potash, and phosphoric acid—the most important constituents taken up by them from the soil, as follows:

Age of tree	Nitrogen	Potash	Phosphoric acid
	Kilos	*Kilos*	*Kilos*
First 4 years	4.477	10.713	1.129
From 5 to 8 years	16.193	34.89[illegible]	8.876
From 9 to 20 years	13.095	20.788	7.148
After 20 years	2.3[illegible]9	13.848	4.277

The percentage of nitrogen taken up by the coffee plants from the different fertilizers, as published in the Indian Scientific Agriculturist, No. 6, Volume 7, June 1926, is as follows:

Nitrate of soda	100
Sulphate of ammonia	75
Nitrolim	69
Dried blood	65
Horn shavings	65
Green manure	65
Fish manure	60
Bone meal	60
Farmyard manure	40
Leather waste	25

By proper crop rotation the fertility of the soil is more or less conserved and not reduced to the same extent as when the land is planted to the same or to a permanent crop like coffee; and as the coffee plant draws the same kind of plant foods away from the soil, it is but logical that the soil should become poor in the particular plant foods required by this plant. Coffee is reported to be a voracious nitrogen feeder and therefore this element should be given first consideration. The addition of nitrogen to the soil is done either by planting cover crops and plowing these under when fully mature or by adding artificial manures or fertilizers. The question of determining what fertilizers are to be applied for coffee and how to use them to the greatest advantage to the plant is a most important problem for the planter to think of before any attempt is made to fertilize the crop. It should be borne in mind also when applying the fertilizer that it should be placed where the root hairs are located. And in the case of coffee plants the root hairs are

mostly located at the growing points of the lateral roots, which roots extend as far as the branches spread.

Various fertilizer mixtures have been reported to have given good results for coffee. In India, for instance, the following mixtures are used with excellent effect on average coffee soil per acre:

Mixture	Amount	N	P_2O_5	K_2O
	Kilos	*Kilos*	*Kilos*	*Kilos*
Nitrate of soda	124.73	18.82		
Superphosphate	63.50		26.98	
Muriate of potash	45.35			22.67
Total	233.58	18.82	26.98	22.67
Nitrate of soda	63.5	9.97		
Fish guano	117.93	8.16	9.07	
Muriate of potash	45.35			22.68
Total	226.78	18.13	9.07	22.68

These mixtures should be slightly forked into the soil soon after the harvest or in two applications,—one just after the harvest and the other six months later.

In Guatemala the following mixtures are reported to have given good results:

Mixture	Rate per tree	Yield per tree
	Grams	*Grams*
Control		464.94
Double superphosphate	68.04	623.70
Potassium sulphate	164.43	
Ammonium sulphate	263.66	
Double superphosphate	68. 4	878.86
Ammonium sulphate	263.66	
Muriate of potash	164.43	
One-half of—		1,315.45
Superphosphate	119.07	
Potassium sulphate	82.22	
Ammonium sulphate	68.04	
Animal dung		
One-half of—		1,349.47
Superphosphate	32.02	
Potassium sulphate	82.22	
Ammonium sulphate	135.41	
Animal manure		

In Hawaii coffee as a general rule is planted for from 3 to 4 years without fertilizer. After this period a certain mixture of artificial fertilizer is applied at the rate of about 280 kilos per hectare twice a year or 560 kilos per year.

Other authors reported that the following mixtures have given good results:

1. For the first four years, 0.113 kilo per tree of a fertilizer mixture containing 5 per cent N, 10 per cent K_2O, and 6 per

cent P_2O_5. For the 5th to 8th years, 0.907 kilo per tree of a fertilizer containing 4 per cent N, 10 per cent K_2O, and 7 per cent P_2O_5, and for the 8th or over 0.907 kilo per tree containing 4 per cent N, 10 per cent K_2O, and 8 per cent P_2O_5.

2. For every 100 trees:

(*a*)	Kilos
Nitrate of soda	39.916
Basic slag	39.916
Muriate of potash	29.937
Total	109.769

(*b*)	
Nitrate of soda	12.707
Superphosphate	22.679
Muriate of potash	9.979
Total	45.365

From the fertilizer test conducted at the Lamao Experiment Station, Lamao, Bataan, during the year 1924 on the Excelsa coffee, the following yields for three consecutive years after the application of the fertilizers were obtained:

No.	Fertilizer mixture	Rate per tree	Method of application	Yield of clean coffee per tree			
				1924-1925	1925-1926	1926-1927	Average
		Grams		*Kilos*	*Kilos*	*Kilos*	*Kilos*
1	Dried blood	750	B	1.984	1.575	.....	1.784
	Potassium sulphate	600					
	Acid phosphate	1,500					
2	Dried blood	500	B	0.560	.....	.....	0.560
	Potassium sulphate	400					
	Acid phosphate	1,000					
3	Dried blood	500	B	0.175	0.090	0.132	
	Potassium sulphate	200					
	Acid phosphate	500					
4	Ammonium sulphate	450	B	0.312	1.225	0.500	0.679
	Potassium sulphate	600					
	Acid phosphate	1,500					
5	Dried blood	750	B	0.200	.....	.....	0.200
	Potassium sulphate	720					
	Acid phosphate	2,250					
6	Dried blood	500	B	2.000	0.700	.....	1.350
	Potassium sulphate	480					
	Acid phosphate	1,500					
7	Dried blood	250	B	0.920	0.350	0.250	0.506
	Potassium sulphate	240					
	Acid phosphate	750					
8	Ammonium sulphate	450	B	0.592	2.800	.....	1.696
	Potassium sulphate	720					
	Acid phosphate	1,500					
9	Ammonium sulphate	190	B	0.256	.....	.....	0.256
	Potassium sulphate	180					
	Acid phosphate	450					

NOTE.—B stands for broadcasted fertilizers.

No.	Fertilizer mixture	Rate per tree	Method of application	Yield of clean coffee per tree			
				1924-1925	1925-1926	1926-1927	Average
		Grams		*Kilos*	*Kilos*	*Kilos*	*Kilos*
10	Copra meal	2,720	B	3.672	5.425	0.800	3.299
	do	2,720	H	0.480	0.350	2.000	0.943
	do	2,720	T	.....	.....	3.750	3.750
	Dried blood	327	B				
	Superphosphate	540	.....	0.440	5.337	0.800	2.192
11	Potassium sulphate	1,820	.....				
	do	1,832	H	0.562	1.837	2.860	1.753
	do	1,832	T	0.652	0.525	1.920	1.032
	Ammonium sulphate	190	B				
	Superphosphate	54	.....	2.600	4.025	0.750	2.458
12	Potassium sulphate	180	.....				
	do	180	H	0.096	0.315	0.590	0.333
	do	180	T	3.232	0.700	0.900	1.610
	Guano	150	B				
	Potassium sulphate	240	.....	2.920	2.800	0.180	1.966
13	Tankage	750	.....				
	do	750	H	1.088	3.587	2.260	2.311
	do	750	T	0.424	1.925	1.090	1.146
	Ammonium sulphate	150	B				
	Potassium sulphate	2	.....	0.112	1.268	2.750	1.376
14	Acid phosphate	500	.....				
	do	500	H	1.356	1.575	0.760	1.230
	do	500	T	0.400	1.137	0.130	0.555
	Dried blood	33	B				
	Potassium sulphate	180	.....	1.468	2.275	1.050	1.598
15	Tankage	640	.....				
	do	640	H	0.448	0.175	0.350	0.324
	do	640	T	0.480	0.525	7.400	2.801
	Guano	390	B				
	Potassium sulphate	18	.....	5.160	4.611	.....	4.885
16	Bone meal	390	.....				
	do	390	H	4.288	1.540	2.360	2.729
	do	390	T	0.372	5.862	0.610	2.281
	Dried blood	32	B				
	Potassium sulphate	180	.....	1.630	3.307	.....	2.468
17	Bone meal	390	.....				
	do	390	H	1.036	1.537	0.450	1.008
	do	390	T	2.400	2.000	0.370	1.590
	Ammonium sulphate	190	B				
	Potassium sulphate	180	.....	1.032	2.450	5.400	2.994
18	Acid phosphate	450	.....				
	do	450	H	2.152	1.977	3.250	2.459
	do	450	T	0.380	0.420	.....	0.266
	Dried blood	330	B				
	Potassium sulphate	180	.....	0.368	2.030	1.100	1.166
19	Acid phosphate	450	.....				
	do	450	H	0.720	0.787	0.140	0.549
	do	450	T	3.024	3.222	3.200	3.142
	Control	.....	.....	1.144	1.632	2.010	1.595

NOTE:
B stands for broadcasted fertilizers.
H stands for fertilizers applied in holes.
T stands for fertilizers applied in trenches.

These mixtures were either broadcasted or applied in holes or in trenches. Generally the former system gave the best results. Trees treated with fertilizer mixtures No. 10, 11, 13, 16, 17, 18, and 19 gave higher yields than the control trees but the highest yields were obtained from mixtures No. 16, 10, and 18.

REJUVENATION OF OLD AND UNPRODUCTIVE TREES

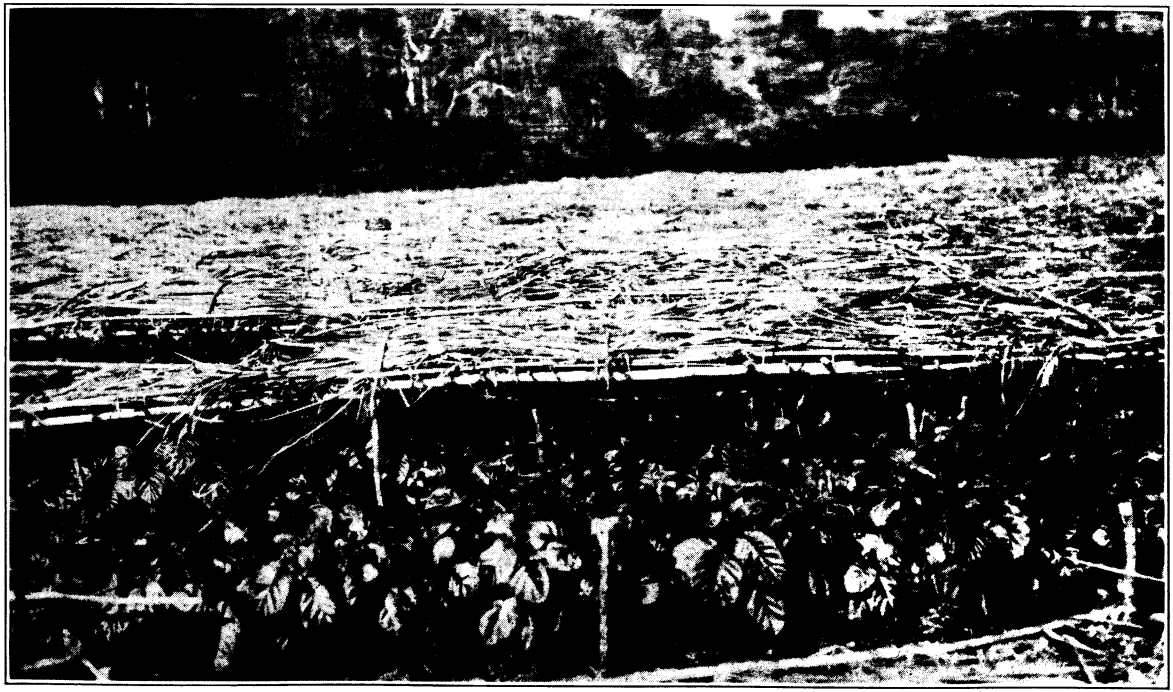
Manuring, cover-cropping, top-working, thinning, and planting of shade trees should be done in the rejuvenation of the improperly planted and unproductive trees.

In a coffee plantation where the trees are planted either too close, without shade, in irregular rows, or sometimes with excessive shade, the coffee should first be thinned out to the proper distances according to the variety. Wherever found, the superfluous shade trees should also be thinned out, and all underbrush cut out. On the other hand, if the shade is insufficient, more should be provided, as already directed, in setting out a new plantation. And if the soil is deficient in plant foods manuring and cover-cropping should be resorted to.

Top-working.—The old as well as the young unproductive trees may be made to bear by top-working. This saves the expense of planting new ones, and the trees so treated produce a crop within a shorter time. This method is as follows:

The trees should be lopped at a height of about 25 centimeters above the ground, as are the newly budded trees in the nursery. Numerous sprouts will soon be produced from the stump. As soon as these sprouts are about 30 centimeters tall the lopped part may be entirely severed from the stump and removed. Only two out of the numerous suckers should be allowed to develop for grafting with scions taken from a known productive tree. The shoots to be selected must be growing on opposite sides of the cut trunk. In cutting off the extra twigs no stubs should be left in order that the cuts may heal quickly instead of decaying and in order that the growth of numerous wild or water sprouts may be prevented. When the two newly grafted branches are well under way cut off the poorest and leave only one to develop into a tree. The operation of lopping may well be performed during the active growth of the plant, which takes place usually at the beginning of the rainy period. During this time there is little chance for the decay of the cut trunk, which if cut during the rainy season becomes a breeding place for insects and fungi. In cutting the trunk a clean cut should always be made, and the exposed part should be painted with white lead or coal tar.

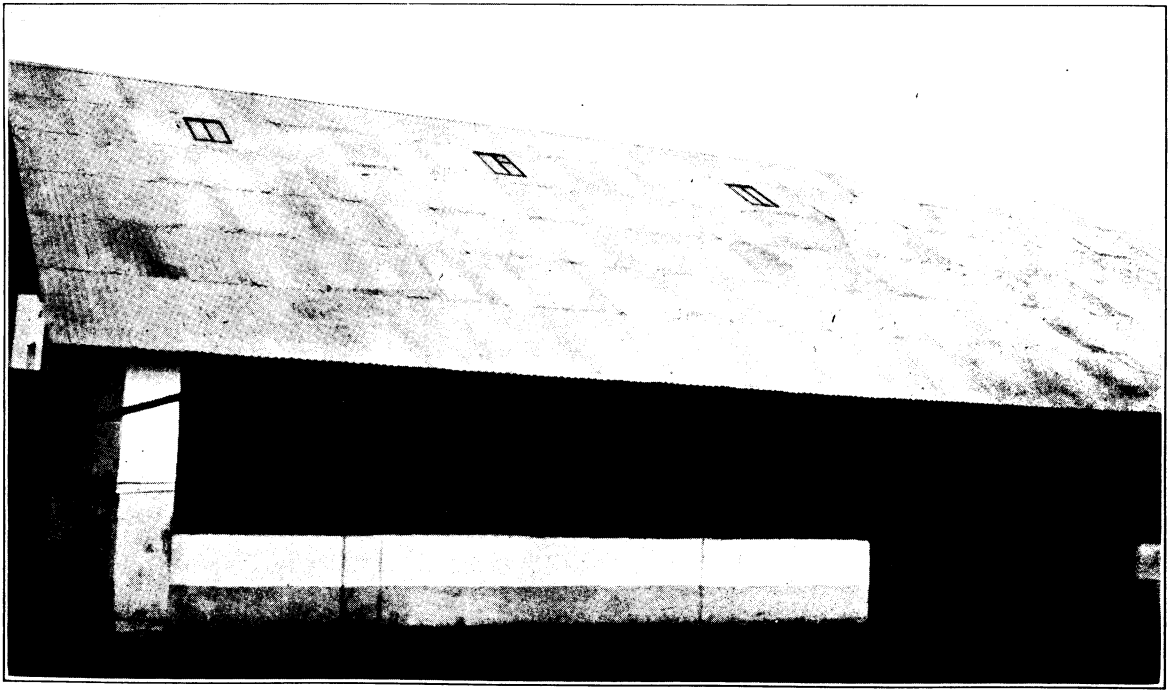
Budding or grafting the top-worked tree is performed in the same way as on young seedling stocks in the nursery, and the necessary care should be taken subsequently to remove the wild or water sprouts, the lopped branches, etc.



Coffee nursery at the Bangelan Coffee Experiment Station, Java

Coffea congensis at the Bangelan Coffee Experiment Station, Java

A coffee sun-drying house (side view), Bangelan, Java



Coffee factory-house at the Bangelan Coffee Experiment Station, Java

DISEASES AND PESTS [1]

The diseases will be discussed under the following heads: (1) Root Diseases, (2) Stem Diseases, (3) Leaf Diseases, (4) Berry or Fruit Diseases, (5) Seedling Diseases, and (6) Miscellaneous.

ROOT DISEASES

Brown root-rot.—The brown root-rot, caused by *Fomes lamaoensis* Murr., frequently attacks young trees. It may be detected by the presence of soil crust and small stones around the affected roots. This crust sometimes appears on the collar of the tree above the surface of the soil and dark brown fungus threads may be discovered in it. In the advanced stage of the disease the leaves lose their color, the branches die back, and the tree may suddenly topple over in a gale, as its roots will have become decayed. A tree affected with the brown root-rot disease should be dug up, all broken pieces of roots removed and burnt and the soil exposed to sun or disinfected with fungicide. The diseased area should be isolated by digging a trench around it. All excavated soil should be thrown inside the circle.

Root-rot.—The root-rot disease, caused by *Armillaria mellea* Quel., is similar to the brown root-rot. It frequently attacks both the tap and lateral roots. It is first visible on the trunk above the ground level. The fungus mycelium may extend from the roots to the trunk and branches of the infected tree. The affected roots are damp to the touch when freshly split open. The presence of the fungus is to be detected by the whitish streak and patches of mycelia between the bark and wood. The rhizomorphs, which are black in color, are capable of traveling through the soil and of infecting whatever roots they may come in contact with.

The disease may be controlled by employing the same methods recommended for the brown root-rot disease. In addition all rhizomorphs should be removed and destroyed.

Stump-rot.—The stump-rot disease is probably caused by *Hymenochaete noxia*, the same fungus that causes the brown root-rot disease of tea and rubber. As the name indicates this disease ordinarily arises from the decaying stump of some jungle tree which has been cut down and left to rot in a coffee plantation.

[1] Prepared by Dr. N. G. Teodoro and Mr. F. Q. Otanes of the Pests Control Division.

Diseased or dead coffee brush when dug up may be found with the roots encrusted with a gritty mass of earth, small stones, and fungus growth. When this encrustation is removed the badly affected parts of the roots may be recognized by their dark brown color.

Isolation by trenching and digging out the decayed stumps and burning them is the one effective means of preventing further dissemination of the disease. Disinfecting the hole with unslaked lime and leaving it alone for about six months has been found beneficial. If the trees are not suffering badly, it will sometimes be sufficient to expose the roots, and paint them with carbolineum or creoline solution.

Root mealy-bug disease.—This root disease of coffee is probably due to the associated attack by a fungus (*Polyporus coffeae* Wakef.) and a scale insect (*Pseudococcus citri* Risso.). It is not known which of these two is the primary cause, and it is believed that neither the one nor the other is individually responsible but that the two work together. The cottony mycelium of the fungus serves as a secure inclosure or nest for the eggs of the female mealy bugs. It is not unlikely that the fungus acts as a semi–parasite and destroys the coffee roots after they have been attacked by the scale insect.

To control the disease it is advisable to give early attention to the scale insect. Usually the presence of a coating makes treatment hard if not impossible. However, the coating can be scraped off and tobacco-soap solution or lime-sulphur mixture sprayed on the diseased parts. The removal of all seriously infested roots is the most practical method of control.

Black and white-root disease.—A root disease named the black- and white-root disease according to the colors of the fungus associated with it, is caused by a soil fungus belonging to the genus *Resellinia.*

The black type, which is the most common, is characterized by the yellowing and falling of the leaves, beginning with those on the lower branches. In its early development the parts of the trunk just above the ground are covered with a thin brown coating of the fungus mycelium. This extends to the roots as brown colored strands that become black as the disease progresses. A newly killed tree may be found with the inner tissues of its bark penetrated by the fungus.

The white type is, however, rare in its occurrence. This type exhibits practically the same characteristic features as the black type, except that in the latter case the progress is very slow

and is marked by the dying only of the infected areas. The fungus is believed to be saprophytic but as the stumps furnish it an abundant supply of food materials, it becomes active and strong enough to attack the living plants.

Control measure consists of digging a ditch around the infected plant to prevent the fungus from passing from one tree to another. The ditch is cleaned out from time to time so as to permit no accumulation of vegetable matter. In severe cases the removal of the infected trees as soon as the disease manifests itself is advisable. No litter should be allowed in a plantation, as it is an ideal medium whereby the fungus can pass from one plant to another.

STEM DISEASES

Die-back.—The die-back disease of coffee sometimes causes partial or complete destruction of coffee bushes. It is characterized by the blackening of the tips of the affected twigs. They appear lifeless although in some cases they may bear a pair of apical leaves. Often the twigs affected are entirely defoliated, and then the twigs die back and later become black and brittle.

Several species of fungi are suspected of causing the trouble, among those of prime importance being *Colletotrichum coffeanum, Fusarium coffeicola, Phoma,* and *Fusarium* found associated with the infected twigs. It is not known which of these fungi is the primary cause of the disease. Some attribute it to the *Hemileia* fungus, while others think it due to physiological troubles, such as overbearing and the presence of conditions inimical to the welfare of the plants. The disease is more prevalent in stony and eroded hilly or hummocky plantations.

Careful selection of seeds from disease-free stock and good culture, including the eradication of noxious weeds and undesirable shade, and proper pruning to prevent overbearing, constitute effective methods of control. Where the disease prevails on stony and eroded slopes, contour canals or catchpits should be dug to prevent erosion of the surface soil.

Pink disease.—The pink disease, caused by *Corticium salmonicolor* B. *et* Br., injures coffee plants considerably. It affects mostly the small branches and twigs but often occurs on the main branches. The leaves are sometimes affected also. The most conspicuous symptom is the appearance of a pink-colored coating on the affected branches. The pink layer is extremely thin, and when old, splits everywhere in lines more or less at

right angles to one another. The growth continues rapidly during the rainy season, killing the bark and peeling it off in large patches, thus exposing the wood.

In the early stage of the disease scraping off the fungus mycelia (the pink layers) and painting with lime-sulphur or Bordeaux paste is an effective method of control. In severe cases the affected branch or branches should be cut off and burned to prevent further dissemination of the disease. The wounds thus produced should be sealed with hot asphaltum to prevent infection.

LEAF DISEASES

Coffee rust.—The coffee rust, caused by *Hemileia vastatrix* B. *et* Br., is mostly confined to the leaves of coffee, but sometimes it occurs on fruits and perhaps near the tips of the young branches and causes die-back. In its early stages coffee rust appears as small yellowish spots about a millimeter or two in diameter on the under surface of the leaves. As the disease develops the color deepens to orange color.

The colored powdery substance is composed of fungus spores. In advanced stages of the disease the same spots become visible on the upper surface of the leaves. Usually plants of all ages are affected, and in severe infection the plants may be entirely defoliated.

The disease may be controlled by collecting and burning all the infected leaves and berries, and cutting off and burning the infected twigs and branches. Spraying with Bordeaux mixture is also recommended. In starting a new plantation, Excelsa, Robusta and Liberica, which have been found resistant to the disease, should be planted.

Brown-eye-spot disease.—The brown-eye-spot disease, caused by *Cercospora coffeicola* B. *et* Cke., occurs both on the leaves and berries. On the leaves it appears as small circular spots, measuring from one-eighth to one-half inch in diameter. In the early stage of infection the spots are bright in color. As the disease develops the center of the lesions become greyish-white or yellowish-brown in color, with a diffused margin. The lesions are very distinct on the upper surface of the leaves, but fructification of the fungus takes place on both surfaces of the affected leaves.

Collecting the infected leaves and berries and destroying them completely by burning will usually check further dissemination of the disease but in severe cases spraying with Bordeaux mixture is advisable.

Koleroga leaf-spot.—The Koleroga leaf-spot disease (caused by *Corticium koleroga* (Cke.) v. Hoeh.—*Pellicularia koleroga* Cke.) appears as a fine, smooth, membranous, greyish-white film covering the surface of the affected leaves. This membrane is somewhat brittle when dry, but flexible and easily peeled off when wet. It can be traced as a narrow band down the petiole and along the branches, sometimes covering a considerable distance. Its tendency is to spread toward the tips of the branches.

Good cultural practices and collecting the infected leaves and burning them and spraying with Bordeaux mixture are effective methods of control.

Leaf-spot.—Leaf-spot, caused by *Stilbella flavida,* is characterized by the presence of small circular spots that vary in shape as they increase in size on account of the obstruction of the veins. These spots are usually some six millimeters in diameter at first but invariably grow larger as the disease advances. Often two or more spots may fuse together giving entrance to other destroying fungi that infect the intervening tissues and produce spots of considerable size. On the lower and upper surfaces of the lesion on the affected leaves are produced several hair-like excrescences each bearing a head like a tiny pin. These are the fruiting bodies of the fungus and are produced continuously under favorable weather conditions. Sometimes the fungus (*Stilbella flavida*) also attacks the young trees and berries. It occurs most frequently in long-continued humid weather.

To check the development of the fungus excess shade trees should be removed to give aëration in the plantation. All infected twigs, leaves, and berries should be collected and burnt up. Under favorable weather conditions, spraying with Bordeaux mixture is recommended.

Other leaf-spot diseases.—Among the other leaf-spot diseases may be mentioned those caused by *Mycosphaerella coffeicola* and *Micropeltis mucosa.* The former produces lesions that appear as small, roundish, and greyish-white spots surrounded by deep narrow bands, while the latter produces minute, scale-like spots, that are present on both sides of the leaves. Both diseases cause little or no damage, however, and can be prevented by strict sanitary measures.

Brown blight.—The brown blight disease of berries, caused by *Colletotrichum coffeanum* Nk., also attacks the leaves, appearing as small, irregular brown spots on the edges. As the disease progresses the lesions become grey and produce small black,

pin point-like bodies. These bear the fruiting bodies of the fungus which give rise to myriads of spores.

Good cultural practices and moderate shade will at least prevent the disease from becoming severe.

Cobweb disease.—The cobweb disease, caused by a fungus possessing sterile mycelia, affects the twigs and leaves of old coffee bushes. The fungus mycelium forms thick, white branching strands, which anastomose on the under surface of the leaves into a fine, cobweb-like layer—hence its name. The fungus growth can be easily peeled off when wet. The affected leaves lose their color, become flaccid, and fall off. The disease occurs frequently only in damp places and in heavily shaded plantations.

Modern methods of cultivation and the elimination of too much shade are the best methods of control.

BERRY DISEASES

Berry blotch.—The berry blotch disease, caused by *Cercospora coffeicola* B. *et* Cke., affects the skin and pulp of the berries. The fungus infects the inner tissues of the beans causing the skin to adhere to them and making them break with the pulp during the pulping operation, and consequently produce a "low-grade" coffee. The presence of the fungus is not apparent until the berries begin to turn red when ripening. In some cases the fungus does not interfere with the normal development of the berries. However, once the berries are affected they shrivel and blacken, and insects and saprophytic fungi, such as mold, etc., destroy them completely.

Persistent spraying with Bordeaux mixture as often as the weather conditions permit will check the disease. In continuously damp weather, when the development of the fungus is hastened, the frequent application of the fungicide is necessary.

In case of slight attack collecting and burning of all infected berries should be done to prevent further dissemination of the disease.

Brown or berry blight.—The brown or berry blight disease, caused by *Colletotrichum coffeanum* Nk., which is serious on coffee leaves, does little damage to the berries. The disease appears as oval or circular-shaped spots, edged by a light brown ring slightly sunk below the level of the rest of the skin. The fungus does not penetrate the inner tissues as in the case of berry blotch disease.

Spraying with Bordeaux mixture and maintaining sanitary conditions will serve as effective control measures.

Defective beans.—The defective beans known as "lights" or "floaters" are undoubtedly due to the associated effect of the attack of various diseases affecting coffee bushes. Among those referred to the *Hemileia* leaf spot, the prevalence of die-back, *Colletotrichum* blight, *Cercospora* blotch, and berry blight cause the discoloration of defective beans. The attacks of insects such as the berry borer and variegated bugs are responsible to a great degree for the production of defective beans. Climatic conditions during the ripening of the crop contribute to a great extent to the production of defective beans. Conditions should be made to suit the requirements of the bearing trees. Then employing the control measures recommended for the diseases mentioned will minimize the production of defective beans.

SEEDLING DISEASES

Damping-off.—The damping-off disease of seedlings is caused by various common soil fungi such as *Rhizoctonia* and *Sclerotium.* Both these occur frequently on seedlings grown in unsterilized and in poorly aërated soil. The disease is recognized by the blackening of the stem of the seedlings above the ground. The discolored lesions later shrink and fall off. Oftentimes the infection spreads to the leaves, developing a black rot. The infection becomes severe during the rainy season on seedlings in damp places.

Growing seedlings in sterilized, well-aërated soil will prevent this. Infected seedlings in the seed-bed should be removed and destroyed as soon as the disease manifests itself. The seed-beds should be exposed to sunlight for at least some part of the day to prevent dampness of the bed, as this favors the rapid development of the disease.

MISCELLANEOUS

Witches' broom.—Witches' broom occurs frequently as a close mass of hypertrophied shoots of primary and secondary branches. It is sometimes caused by insect injury, and sometimes by fungus attacks. Removing the branches and twigs bearing witches' broom and burning them will prevent its further development.

Loranthus stem parasite.—The most common parasite of the stem and branches of coffee is a flowering plant botanically known as *Loranthus.* This kills the branches on which it grows and in time kills the whole plant. The *Loranthus* bears flowers and fruits and so spreads from tree to tree. The leaves of the

parasite differ to a great extent from the leaves of the host plant, hence it can be easily detected even before the flowering season.

Removing the branches bearing the parasite as soon as they are discovered and burning them all is the most economical and effective method of control.

Sooty mould.—The sooty mould caused by *Capnodium brasiliensis* Put. which affects the leaves sometimes affects the stems and branches also. The disease forms a coating on the surface of the leaves. The fungus, however, is not parasitic in its nature but it interferes with the photosynthetic activities of the leaves. Its presence is an indication of the presence of some destructive agents such as scale insects and mealy bugs. The fungus lives upon the "honey dew" excreted by these insects.

Spraying with a kerosene emulsion or a tobacco decoction is recommended for its control. This is to kill the insects, but the sooty mould fungus will disappear after the insects are destroyed or driven away by the spray solution.

As in the case of other important crops, no systematic and prolonged studies have been made of the insect pests, as well as other enemies of coffee. Nevertheless, it has been considered advisable to prepare the following brief account of the most important pests attacking the coffee plant, with recommendations and suggestions as to methods of control, for the benefit of planters as well as others who are interested.

INSECTS ATTACKING THE ROOTS

Grubs.—The larvae or grubs of the "toy-beetle" (*Leucopholis irrorata*) have been observed to attack the roots of coffee seedlings in nurseries. When abundant they may kill a considerable number of the young plants. The grubs can be controlled by digging them out or by injecting carbon bisulphide into the soil. Collecting the adult beetles as soon as they appear in May or June has proved effective.

For further information about this pest and its control, see Circular No. 166 of the Bureau of Agriculture.

INSECTS ATTACKING THE STEM, BRANCHES, AND TWIGS

There are recorded several species of different genera and families of beetles which attack the stem and branches of coffee. One of these is a tiger beetle (*Collyris albitarsis*) the larva of

which tunnels the stem. Another larva which injures coffee in the same way is that of a long-horned beetle, *Monohammus fistulator*. A third is a very tiny beetle of the family *Scolytidæ*. Both the adults and the larvæ of this last species bore into the stem and branches of coffee.

The first two species are not usually numerous. Collecting the beetles and extracting the larvæ from their tunnels may suffice to control the pest and prevent their spread in the plantation. Injecting paradichlorobenzene crystals into the tunnels of the larvæ or grubs may also be done.

The third species of beetle usually attacks weakened or old coffee plants, portions of the stems and branches of which are dead or dried up. Cutting off and burning the badly-infested branches and twigs as well as dead plants will help reduce the damage by the pest. Spraying the plants, especially the stems, with lime-sulphur or with lead or calcium arsenate may be practiced.

INSECTS ATTACKING THE TWIGS AND LEAVES

Slug caterpillar.—There is one slug caterpillar, the caterpillar of a moth, *Thosea* sp., that attacks the leaves of coffee. This caterpillar is green and armed with spines, which have an irritating effect upon the skin.

When the caterpillars are few they may be removed from the plants with bamboo forceps and crushed. When abundant they can be killed by spraying the plants with soft laundry soap solution, at the rate of one-half kilo dissolved in about 20 liters or one petroleum canful of water. To make the spray more effective lead or calcium arsenate at the rate of 2 to 5 grams per liter should be mixed with the soap solution. The mixture acts both as a contact and a stomach poison.

Bagworms.—Bagworms often become troublesome in coffee plantations. These are the caterpillars of a moth of the family *Psychidæ*. They are so called because they are protected by bags constructed by the worms themselves. When there are only a few, the worms can just be picked off the plants, but when abundant the plants need to be sprayed with lead or calcium arsenate at the rate of 2 to 5 grams per liter of water. It is best if soap solution is used together with the lead arsenate as the soap serves as a sticker.

Aphids or plant lice.—Aphids or plant lice are sometimes found attacking coffee. These insects suck the juices of the plants.

These may be killed by means of soap solution (one-half kilo of soft yellow soap, Chinese soap, for example) or kerosene emulsion. The latter is prepared according to the following formula:

Kerosene	8 liters
Soap	0.3 kilo
Water	4 liters

The soap is cut into bits and dissolved in the water by boiling. Thereafter the container is withdrawn from the fire and the kerosene is added little by little the solution being vigorously churned at the same time. This is best done by pumping the liquid back into the container with a bucket pump until a white creamy solution is obtained. This is the stock solution. For spraying one part of the stock solution is usually diluted with 16 parts of water.

After the complete fertilization of the flowers, especially when the coffee tree is dry, it should be shaken once in a while or every time the wild sprouts are removed to avoid the attack of aphids and plant lice.

Scale insects.—There are several species of scale insects that attack the leaves as well as the twigs of coffee. Like aphids, these insects suck the juices of the plants and inflict some direct injury. The most important of these is the green or coffee scale (*Coccus viridis*) or (*Lecanium viridis*) which has done considerable damage to some coffee plantations in Rizal, and the mealy bugs, there being at least two kinds, *Pseudococcus filamentosus* and *P. virgatus*. The hemispherical scale (*Saissetia hemisphaerica*) and the black scale (*Saissetia oleæ*) are also said to attack coffee.

Soap solution, at the rate of one-half kilo dissolved in 20 liters of water, is a good spray for all of these scales. Nicotine sulphate, if available, is one of the best.

Thrips.—Thrips are sometimes found troublesome. These are also small insects and like scales they suck the juices of the plants. These can also be destroyed by the use of soap solution or by means of nicotine sulphate.

Mites.—Mites or red spiders become especially troublesome during the dry season. Soap solution or lime-sulphur spray is good for these pests. Nicotine sulphate may also be used.

Wild cats and monkeys often damage the crop.

PESTS OF COFFEE IN OTHER COUNTRIES NOT KNOWN TO BE PRESENT IN THE PHILIPPINES

There are a considerable number of coffee pests in other countries not as yet found here and these should be kept out. One

of these is the coffee berry-borer, *Stephanoderes hampei* Ferr. (= *Stephanoderes coffeæ* Hagen). As its name indicates it bores into the berries as well as the dried seeds and can thus be easily introduced. The insect is a small beetle and is from one to two millimeters long. It lays its eggs in the berries and these eggs hatch into larvæ or grubs which feed within the berries. The insect is reported to be bad in Java, Brazil, and in certain other coffee-growing countries. The insect can probably be kept out by restricting or prohibiting the importation of coffee berries from infested countries.

One of the measures used in other countries against the pest is fumigating the seeds with turpentine and carbon dioxide.

The coffee borer is another destructive pest and it has been responsible for the loss of many coffee trees in India.

The so-called shot-hole-borer (*Zerozera coffeæ*) is another enemy, but as it is not found on the seeds, it can be excluded successfully by prohibiting the importation of all shoots upon which the butterflies lay their eggs.

Microscopic nematode worms are reported to be doing much damage to the roots of the Arabian coffee but not to the Liberian and the Excelsa varieties.

The beetle, *Xyleborus coffeæ,* is reported to be a dangerous pest of coffee.

HARVESTING AND YIELD

The method of harvesting coffee in the Philippines is very primitive. The berries are picked one by one, by either men, women or children. When the branches are high, as no topping is practised, the harvester pulls them down and holds them with his feet so that both hands are free to pick the berries, or else they are held down by ropes. Sometimes ladders are used in harvesting low-branched coffee. Picking the berries from the nodes is done very roughly, no precautions being taken not to injure the nodes, which parts are the permanent fruiting places of the coffee plant. Needless to say this method of picking coffee berries should not be used. In some localities the berries, irrespective of their degree of ripeness, are all harvested at the same time while in other places only ripe berries are picked.

This of course is the proper method to get a clean and uniform product that will bring a good price. By uniform here is meant not only the same in size but in color also. Ordinarily a coffee

tree will fruit heavily from the 5th to the 10th year. But before this some berries are produced on the trees, and among these some ripen earlier than others. So harvesting is done as soon as there are any ripe berries, especially in the case of Arabian coffee. The ripe berries of this variety drop off if not gathered at once. In pulling off the berries care should be taken not to injure the nodes by pulling the berries against their natural direction. They should always be pulled toward the outer end of the branches so as not to bruise any of the nodes bearing the berries. If this is not done the productive capacity of the plant will be lessened as it grows old. The ripe berries can be distinguished easily by their red or yellow color and sometimes by their shape.

In the Philippines, harvesting in most cases is done on a share system whereby the harvester gets from one-fourth to one-half of the crops, and in Java they pay from 2 to 5 guilder cents per kilo of fresh berries—two cents for the first harvest and five cents when there are only a few berries left on the trees.

The productive life of the coffee tree has not so far been determined. In Brazil 60-year old trees have been reported to give better yields than young ones. In Java trees 32 years old and in Hawaii from 40 to 80 years old have been reported to be producing good crops.

The yield of coffee is quite variable, much depending upon the soil and climatic conditions of the place, and the treatment accorded to the plantation. Generally speaking and under good cultural treatment the yield of Arabian coffee for the third year is about 90 kilos of clean coffee and thereafter increases to 400–800 kilos to the hectare. In Hawaii, 1,220 to 2,250 kilos of clean coffee per hectare have been recorded. In Hamakua, Hawaii, yields of from 550 to 675 kilos per hectare have been obtained from the Guatemalan variety, and in Porto Rico a yield of 355 kilos. The yield of Arabian coffee in the Philippines has ranged from 0.55 to 1.00 kilo per tree for the last 13 years or an average of 0.77 kilo of clean coffee per tree. At this rate if 1,333 trees were planted to the hectare the yield would be 1,026 kilos per hectare.

The Robusta type when in full bearing produces from 800 to 1,000 kilos of clean coffee per hectare while the yield of the Liberian type varies from 500 to 700 kilos, now and then exceeding the latter figure. At the St. Clair Experiment Station, Excelsa coffee 10 to 11 years old yielded 4.09 kilos per tree. At the Lamao Experiment Station, Lamao, Bataan, the yields ob-

tained from the different varieties of the Liberian type are as follows:

Coffee yields at the Lamao Experiment Station

Variety	Year planted	Average yield per tree of clean coffee				
		1919	1920	1921	1922	1923
		Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*
Liberian	1917				0.513	0.638
Excelsa	1916	0.128	0.147	0.871	1.409	1.132
Dybowskii	1919					0.192
Excelsa	1917					0.132
Liberian	1917					
Abeocuta	1917					

Variety	Year planted	Average yield per tree of clean coffee				
		1924	1925	1926	1927	Average
		Kilos	*Kilos*	*Kilos*	*Kilos*	*Kilos*
Liberian	1917	1.557	1.376	2.164	1.022	1.212
Excelsa	1916	1.519	1.329	1.815	1.390	1.082
Dybowskii	1919	0.119	0.435	1.136	0.314	0.439
Excelsa	1917	0.792	0.438	0.981	1.422	0.753
Liberian	1917	0.889	0.951	1.558	0.580	0.995
Abeocuta	1917		0.472	0.907	0.107	0.495

The land where the Excelsa, Liberian, and Abeocuta coffee trees were planted in the year 1917 was and still is rather poorly drained and as a result low yields have been obtained from all the varieties except the Liberian in field "E" which has given an average yield of 1.212 kilos of clean coffee per tree, but trees of this variety are planted on as good soil as that on which Excelsa was set out in 1916.

The yields of the various coffee varieties planted in 1916, with the exception of the Abeocuta, which was planted in 1917 at La Carlota Experiment Station, La Carlota, Occidental Negros, are as follows:

Coffee yields at La Carlota Experiment Station

Variety	Distance	Yield per tree of clean coffee in nine years						Computed yield per hectare
		1918 to 1921	1922	1923	1924	1925 to 1926	Total	
	Meters	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Kilos*
Abeocuta	3.5	15.20	101.40	24.30	11.90	283.00	435.80	59.27
5466-Canephora	2.7	47.97	62.10	47.70	14.70	844.40	1,016.87	154.78
5467-Canephora	2.7	103.10	85.70	98.10	55.20	218.70	560.80	85.36
5388-Congo	2.7		38.10				30.10	52.20
5468-Congo	2.7		2.70				2.70	3.70
5389-Excelsa	4.0	8.20	109.00			202.90	320.10	50.01
5369-Excelsa	4.0	4.00	499.10			410.70	913.80	142.78
Robusta	2.7	43.04	358.00		310.00	23.70	734.74	143.80
5454-Robusta	2.7	5.60	22.70			191.10	219.40	75.14
5460-Robusta	2.7	48.61	41.70	27.70		372.90	490.91	84.06
5461-Robusta	2.7	18.30	21.50	84.10	24.30	114.90	263.10	40.05
5463-Robusta	2.7	25.30	64.10			37.80	127.20	24.89
5464-Robusta	2.7	8.14	43.50			164.00	215.64	59.09
5287-Quillou	3.0	16.00	248.30	28.90		302.50	775.70	172.36
5465-Quillou	3.0	31.50	182.30	122.30		355.60	691.70	109.78
5470-Uganda	2.7	29.79	23.20	23.10		1,350.00	1,426.09	244.22
5471-Uganda	2.7	59.50	81.30	112.80	53.60	472.70	779.90	133.52

The average yields of the Robusta coffee as reported in 1923 at various places in Lipa, Batangas, are as follows:

Yields of Robusta coffee at Lipa, Batangas

Year planted	Distance	Yield per tree of clean coffee	Computed yield per hectare	Shade
	Meters	*Grams*	*Kilos*	
1909	3 × 3.5	525	499.80	Anae and madre-cacao.
1914	3 × 4	450	374.85	Madre-cacao.
1915	4 × 4	53	33.13	Anae and madre-cacao.
1916	3 × 3	98	108.88	Madre-cacao and bananas.
1917	3 × 3	1,500	1,666.50	Do.
1919	4 × 4	90	56.25	Anae.
Average	.....	453	456.57	

PREPARATION

Coffee berries have a reddish outside husk, called the *pulp,* within which is an envelope of gelatinous matter resembling glucose, called the *slime,* that surrounds a tough, parchment-like *hull,* which loosely covers the pellicule, or *silverskin,* which, in turn, is more or less closely adherent to the true coffee bean. The four envelopes must all be removed completely from the bean as rapidly as possible to obtain a first-class marketable coffee. If the slime is left on after husking, the drying process is likely to be retarded and an inferior article produced. Coffee keeps best in bags with the pulp and slime removed, and the dried hull left on, but the market demands that the silverskin and the hull must always be removed before first-class coffees are shipped. The berries of the different varieties vary in size and the relative ease with which these envelopes can be removed, and the prices and grades are affected by the way in which their removal is accomplished. The preparation of the coffee berries on a large scale before they are marketed is as follows:

At first the freshly picked berries are weighed as they are brought to the mill, for the purpose of paying the pickers. Then the leaves, stones, dirt, and other impurities mixed with the berries while picking are removed by passing them through a revolving drum about 1.5 meters long and 1.2 meters in diameter, made of large meshed screen with a worm of galvanized iron, the flange being 25 centimeters wide and fitted to the mesh on the inside to carry out the dirt, and the mesh being large enough to allow the berries to fall through as the drum revolves. They are next washed in channels filled with water then brought to the pulping machine.

Pulping.—This process will free the berries from the husks, which are removed, and the pulped coffee falls into the ferment-

ing vats usually made of wood or cement and placed directly below the pulper, where they remain to ferment. Berries picked in the morning should be pulped in the afternoon and if pulping is delayed it becomes harder to remove the pulp. If possible the berries should be pulped as soon as they are removed from the trees. The fermentation vats are provided with a vent in the bottom through which the coffee is flushed to a revolving washer. The ordinary pulping machine is a cylinder covered with blunt projections. For every type of coffee a different pulping machine is required, because the present machines are not adjustable to suit the size of the berries of each of the types of coffee. The price of a pulper for small sized berries is about ₱320 and for the larger ones ₱200.

The red flesh and husks are sometimes pressed with weights to remove the water, moulded with the feet into briquettes, and used after sundrying, as fuel with the hulls and dust.

Fermentation and washing.—The slimy substance under the husk is usually removed by some process of washing after fermentation. During the process of washing the pulp from the beans and the remaining skins that have escaped from the pulper may also be removed.

In the dry fermentation process, the pulped berries are left in heaps to ferment for two or three days. And in wet fermentation it is necessary to keep the berries entirely under water in vats for two or several days, the time depending on the altitude, temperature, and climate.

The slimy substance is easily removed after fermentating the beans by a washing process carried on by men who, with large wooden hoes, rub the berries back and forth in the water-filled vats.

The great objection to both these methods of fermentation is that "stink coffee" is often produced by a butyric acid putrefaction, which gives an inferior product. This can be prevented by care and experience, but it must always be watched for, and skilled superintendence is required in order not to ferment the beans too long.

On coming out of the revolving washer the mass falls on a perforated shaker through which is carried away most of the slime and refuse with the water, the coffee dropping into the lower end of a trough about 3.5 meters long, tilted upward at an angle of about 30° containing a revolving worm carrier about 30 centimeters in diameter. As the coffee is being carried upwards in the trough by the screw it is met by a stream of clean

water which rinses it and overflows at the top of the lower end of the trough, carrying with it all "floaters," or light, imperfect beans, which are thus separated and later made into a cheap grade coffee. After passing through the rinsing trough the coffee falls on another shaker for the removal of the few remaining impurities and water, and from there it goes to a chain conveyor which carries it to the drying floor.

A new washing process has been invented by which the berries pass directly from the pulper to a "French" washing machine which removes the slime quickly, and without fermentation, by the friction produced by the two shafts provided with vanes, revolving in opposite directions under water, thus saving time, labor, expense, and the risk of putrefaction. Some ashes, or 600 grams of sifted slaked lime to 4 piculs of wet coffee berries, are usually placed in the machine to hasten the process, which was originally introduced because it was difficult to handle the Robusta berries satisfactorily by wet fermentation.

The machine is especially useful where there is a large harvest and a small supply of water, and the coffee it produces sells at a higher price.

Drying.—After the washing process has been completed, the berries are drained on a galvanized iron plate, perforated with circular holes, and then dried as quickly as possible. But in order to command a good price in the world market, the Robusta and the Liberian types require artificial drying in especially constructed dryers, which because of their cost can not be erected by small individual growers. These drying houses are usually plastered brick buildings with galvanized iron roofs, well ventilated by a space between the tops of the walls and the roofs. At about half of their height, there are floors of galvanized iron plates pierced with circular holes, below which are a number of iron pipes about 18 inches in diameter, through which the smoke and gases from the furnace at one end pass to a heater connecting with the chimney at the other end.

The drying house as shown elsewhere in this article has two drying compartments each consisting of 18 pieces of iron plates for flooring, measured 3 by 6 feet. Each of the compartments has a capacity of two piculs of fresh berries and double when half dried. The fresh berries are first dried in the first compartment and when half dried are transferred to the second one for final drying.

The coffee berries are spread on the floor of the drying house and the fire kept on burning for two or three days or until

the berries are perfectly dried in a temperature of 100° C. for the first 12 to 13 hours, then reduced to 60–70° C. for a similar period, if necessary, after the quantity of berries in the drying house has been doubled.

On many plantations the berries are first sun-dried on a concrete, or plastered brick platform, protected from rain by pieces of roofs, which slide away on wheels or rollers, resting on rails, to expose the berries to the sun. When rain threatens the sliding roofs are pulled over the drying floor on rails overhead by means of cables wound on a drum. Both rails and the drying floor are constructed slightly inclined to one side, so that when it is desired to again uncover the coffee the cover rolls away by gravity merely by releasing a catch attached to the drum on which the cable is wound. Part of the drying floor is covered by canvas thrown over a ridge pole during rainy weather. After a preliminary drying for three or four days on the floor, the drying of the coffee is completed in a hot air drier as described above, after which the coffee is hulled, graded, and sacked ready for shipment.

Hulling.—It is best to hull the coffee as soon as it becomes glass-hard or dried perfectly. The silverskin of practically all varieties is readily removed by the huller, but if the beans are moist, it can only be done with difficulty. In such cases, it is necessary to dry them again, or, if this is not sufficient, put them in bags, steep them in boiling water for a few seconds to expand the silverskin, and then spread them out first to air-dry or put them at once into the drying house. In any case they are put again through the huller after drying. In the hulling machine, revolving cylinders, or worn wheels with vanes, tear off the hull, remove the silverskin, and polish the beans. When it is working well, there should be no broken beans, and if there are any, the machine should be readjusted. Broken, black, and imperfect beans are usually removed by hand picking. The rice huller can be used for this purpose although a coffee huller is preferable in case it is obtainable. The huller is always run by a power engine. To remove all traces of silverskin sometimes it is necessary to pass the beans twice or three times through the huller.

The hulls and silverskin are usually removed with a fan—a fanning apparatus with pipe attached to the huller—and the beans then sorted to size by passing them through a long, revolving cylinder slightly inclined and perforated with holes of various sizes.

The removal of the silverskin is one of the main problems of the coffee industry. Its presence does not in the least affect the flavor or quality of the beans, but only their appearance. The silverskin is removed while roasting the beans, and with the aid of the exhaust fan in the coffee mill, and by winnowing or sifting, when roasted in the home. This is, however, of great importance, as upon it the price largely depends. Berries with the silverskin still wholly or partly adherent usually sell at a lower price, and sometimes will not sell at all, when there is an oversupply. For this reason, the establishment of large plantations is not advisable unless modern machinery is installed for this purpose.

Native preparation.—In the Philippines coffee berries are usually dried in the sun. In Java many planters still prepare coffee by this system. This method of preparing coffee is carried on in three different ways as follows:

1. The ripe berries with husks on are dried in the sun and the native planter removes the dried husks, pulp, slime, hull, and part of the silverskin by handmills or mortars and pestles or with the aid of a rice mill. This system of removing the silverskin can easily be managed with Arabian coffee but with the other kinds of coffee, like the Liberian and the Robusta types, the removal of the silverskin by the native process is rather difficult. Pulping the fresh berries is now being facilitated by the use of a wooden roller as devised at the Lamao Experiment Station, Lamao, Bataan.

2. The berries are first fermented for 24 hours and after that they are washed and dried in the sun until the inner skin separates readily when crushed or pounded in a wooden mortar. This method of drying requires much labor especially in the rainy season. It takes from 30 to 50 days and still there is much loss by decaying.

3. In preparing coffee on a small scale the red coating is peeled off and then the berries are carefully washed. After this they are dried in the sun for 4 or 5 days or until they are ready to be crushed. When dried they are spread on flat boards, and a small wooden roller is rolled over them, thus breaking the second coating or tegmen.

In Brazil, coffee is prepared in two ways, namely, by the dry and the wet systems. The dry method consists of spreading the berries in the sun and protecting them from rains and, when they are dried, storing them in dry places and separating the pulp. By the wet method, the berries are submerged in

a tank of water for several days; then the pulp is removed by trampling and dried afterwards.

If the berries of the Liberian and the Robusta types are prepared by the native system, after they are sun-dried the silverskin can be removed by moistening the beans and redrying them, then passing them through a hand rice mill or other suitable machine, and if still all the silverksin is not removed the operation is to be repeated a second or third time. For if this is not done, the silverskin of the sun-dried berries is very difficult to remove not being loose as in the case of the hot air-dried berries, where quick drying is done.

Immatured and diseased berries should be prepared separately from the good ones so that the latter will not lower their market value. At the Bangelan Coffee Experiment Station, Malang, Java the berries attacked by the beetles are picked separately and put in boiling water for one half to one hour to kill the insects, and then sun-dried before they are finally dried in the drying house, after which they are pulped.

COST OF PLANTING COFFEE

The cost of planting a hectare of coffee land is variable, depending as it does upon the locality, land, type of soil, labor, wages, management, etc. However, for the guidance of the coffee planters an estimate of the expenditure necessary to plant and maintain a hectare of coffee land during the first year may be itemized as follows:

Item	Open	Jungle
Preparation of the land:		
Clearing, stumping and burning	.....	₱100.00–200.00
Plowing (two or three times)	₱20.00– 30.00	.....
Harrowing (two or three times)	6.00– 8.00	.....
Furrowing for the cover crops	2.00– 4.00	.....
Staking, materials and labor	8.00– 10.00	8.00– 12.00
Holing for coffee plants	10.00– 12.00	10.00– 15.00
Putting decayed manure in coffee holes	5.00– 15.00	.....
Planting:		
Permanent shade trees	4.00– 8.00	4.00– 8.00
Temporary shade trees	4.00– 8.00	4.00– 8.00
Coffee seedlings	4.00– 8.00	4.00– 8.00
Cover crops	3.00– 5.00	5.00– 10.00
Catch crops	.....	5.00– 10.00
Maintenance of the plantation:		
General cultivation	6.00– 20.00	.....
Hoeing	6.00– 10.00	15.00– 30.00
Replanting coffee and shade trees	5.00– 5.00	5.00– 5.00
Mulching the coffee	10.00– 15.00	10.00– 15.00
Pruning, thinning and topping:		
(*a*) Shade trees	1.50– 2.00	1.50– 2.00
(*b*) Coffee plants	1.50– 2.00	1.50– 2.00
Miscellaneous work	5.00– 5.00	5.00– 5.00
Cost of seeds:		
Shade trees	1.00– 4.00	1.00– 4.00
Coffee seedlings	19.00– 34.00	19.00– 34.00
Cover crops	2.50– 5.00	2.50– 5.00
Catch crops	.....	1.00– 1.50
Total	₱123.50–210.00	₱201.50–384.50

The items for the maintenance of the plantation may be carried yearly except the replanting, and if the plantation is properly cover-cropped general cultivation may also be dispensed with.

According to Van Leenhoff, formerly of the Porto Rico Agricultural Experiment Station, Mayaguez, it cost as follows to bring one hectare of Arabian coffee into bearing in Porto Rico:

Clearing the land	₱54.34
Staking	10.88
Holing	87.73
Propagation of coffee seedlings in the nursery	24.70
Planting	43.86
Shade trees	7.41
Hoeing (twice)	43.86
Weeding (four times)	26.28
First year's expenditures	₱299.06
Second year's expenditures	76.77
Third year's expenditures	69.90
Total	₱445.73

Wester says that in Java on an estate where labor is obtainable at 16 to 24 centavos per day, the annual cost of upkeep per bouw (0.7 hectare) is as follows:

Machine cultivation	₱0.80
Weeding (hoeing) 6 times per year	9.60
Topping and pruning	5.20
Attention to shade trees	3.20
Clearing jungle around the plantation	0.32
Sundries	0.18
Total	₱19.28

In Porto Rico the expenditure for picking, preparation and transportation to the nearest port is ₱11 per hundred kilos of clean coffee, which is approximately the same as in Java. In the latter country when wages were 16 to 24 centavos a day, the cost of harvesting the berries, the preparation of coffee and the transportation to the nearest port was ₱10.14 per hundred kilos of clean coffee, and when the labor was 24 to 28 centavos a day, the expenditure was ₱11.34.

The over-head charges, interest, depreciation, etc., are not included in the foregoing expenditures.

A small coffee central capable of milling the product of a plantation of from 350 to 400 hectares of coffee may be con-

structed at a cost of about ₱15,000, which sum may be distributed as follows:

Machinery shed and bodega	₱3,500.00
Drying house and dryers	4,400.00
Power plant and huller	3,600.00
Fermentation vats	1,500.00
Sundries such as water plant, etc	2,000.00
Total	₱15,000.00

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COMPARISON OF THE DIFFERENT METHODS OF TAPPING PARA RUBBER

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The object of tapping is naturally to obtain the maximum production of latex with the minimum damage to the tree and at the lowest possible cost. Although various systems are in vogue in different countries, yet it is still a question which system is best adapted to the Philippines; hence this investigation. Different systems of tapping have their own advantages and disadvantages. It is fairly certain that excessive tapping is often responsible for the occurrence of brown bast disease. While the most widely employed system in Ceylon is the one cut on the half-spiral on alternate days, yet in Sumatra daily tapping on one-third of the circumference is done(1).

CLIMATE AND SOIL

The climate of Baco generally resembles that in most of the localities in the Province of Mindoro, which, according to Father Algue's(2) classification of the cimate in the Philippines, belongs to the first type. In general, the rainfall is uniformly distributed throughout the year. There is no distinct wet and dry season. The heaviest rainfall is during November, December, January, and February while the lightest is from March to June. The medium is in July, August, September, and October. Although Mindoro is within the typhoon belt, yet the rubber trees at Baco have not suffered any appreciable damage from storms.

The plantation is protected by hills on the western and northern parts from typhoons, while the eastern and southern portions are exposed to the wind. The ground is level except in the western and northern parts, where it is hilly. Most of the trees tapped in opposite V's are located in the hilly portion. But the majority are on the plain.

The soil ranges from clay loam to loam. The surface soil is quite deep and varies from brownish sandy loam to dark clay

loam. The sub–soil is clayey with pebbles in the hilly portion. The following tables show the physical and chemical analyses of the surface soil and sub-soil as reported by the Bureau of Science from the samples submitted by the Bureau of Agriculture:

TABLE I.—*Mechanical analysis (water-free basis)*

Analysis	Surface soil	Sub-soil
	Per cent	*Per cent*
Coarse sand, 1 to 0.5 millimeter	5.5	5.6
Medium, 0.5 to 0.25 millimeter	9.4	11.6
Fine, 0.25 to 0.10 millimeter	9.1	19.4
Very fine sand, 0.10 to 0.05 millimeter	23.5	21.9
Silt, 0.05 to 0.005 millimeter	40.3	30.9
Clay, 0.003 millimeter	12.2	10.6

TABLE II.—*Chemical analysis (surface soil—water–free basis)*

	Per cent
Loss on ignition	7.17
Nitrogen (N_2)	0.198
Phosphoric anhydride (P_2O_5)	0.109
Lime (CaO)	0.72
Potash (K_2O)	1.447
Humus	0.84
Soil acidity (per cent $CaCO_3$)	0.028

MATERIALS

This experiment was started in July, 1926, on about 12-year old Para rubber trees not previously tapped. The opposite V's system was lately started in January, 1927. The plantation was jungle-checked, for it had been neglected since the corporation that owned it was dissolved. The trees were planted $5\frac{1}{2}$ by $5\frac{1}{2}$ meters apart, but some occupy a wider space now for intervening trees have died. Many have poor bark, for their trunks have been badly mutilated by bolos. The girth measurement, taken November 9, 1927, varies from 18 to 51 inches.

METHOD

Three systems of tapping were tested namely, the half-spiral, V-shaped and opposite V's. There were two sections of 30 trees each for each of the half-spiral and V-shaped methods. One section of each of these two systems was tapped daily in the morning and the other every alternate day. The opposite V's consisted of only one section of 30 trees. Tapping was done alternately every other day.

The half-spiral and V-shaped were started in July 1926. The daily and alternate daily sections of the half-spiral system consisted previously of 44 trees each. In October 1927, the number of trees of each section was reduced to 30. The poor and non-yielding trees were passed over, for they only increased the expense of the experiment. The opposite V's system was started in January 1927, on 40 trees. But as for the half-spiral and the V-shaped systems, the number of trees was reduced to 30 on October, 1927.

Tapping was done in the early morning at 6 o'clock. Only one man was assigned to tap this whole block to prevent errors due to variation in the tappers. The yields of the individual trees were recorded. The latex was collected in glasses of almost uniform shapes and sizes so that the volume was readily measured in cubic centimeters. After the production was recorded, the latex was poured into a bucket and the glass was then washed in another bucket containing fresh water from which rubber number 2 called the cup washings is obtained.

The latex was then brought to the laboratory and all dirt and lumps of rubber strained out. Coagulation was then brought about by adding one part of the stock solution of acetic acid to 50 parts of the latex. The stock solution was prepared by mixing one part of concentrated commercial acetic acid to 20 parts of water. This proportion of acetic acid to diluted latex caused coagulation in from one to two hours. The following morning, the coagulum was first kneaded with a wooden pin roller and finally through a rubber hand roller machine to remove as much of the water as possible to facilitate its drying. Then the milled sheets were carefully washed with fresh water, air-dried, weighed and placed in the smoke house until they were dry enough to give constant weights. It took from 10 to 15 days to dry them. The wet weight of the cup washings and the tree scrap were likewise taken and dried in the smokehouse.

RESULT

The monthly production from July 1926, with the exception of that for the opposite V's system which began in January 1927, to June 1928 together with the totals and their corresponding averages are shown in Table III.

TABLE III

Months	System: Half-spiral, Daily: Latex	Daily: Dry rubber	Alternate daily: Latex	Alternate daily: Dry rubber
1926	*Cu. cm.*	*Pounds*	*Cu. cm.*	*Pounds*
July	41,563	32.82	22,257	17.57
August	45,059	34.51	38,533	29.33
September	27,668	20.38	19,490	14.36
October	18,945	15.21	15,193	22.22
November	21,498	16.31	13,796	10.47
December	17,217	12.57	14,537	10.61
1927				
January	29,199	20.87	27,304	13.52
February	29,186	21.25	22,317	16.25
March	20,066	15.71	17,354	13.59
April	15,323	11.48	10,834	8.10
May	18,199	13.61	13,188	10.60
June	8,429	6.32	16,154	12.11
July	20,013	14.98	15,747	11.78
August	14,382	12.48	7,724	6.70
September	21,946	21.10	8,708	7.98
October	16,800	13.60	8,961	7.25
November	17,523	11.87	7,560	5.12
December	24,400	16.15	15,159	10.03
1928				
January	15,205	10.97	11,692	6.23
February	10,776	8.22	5,826	4.44
March	17,399	13.85	13,905	11.07
April	19,129	14.26	14,426	10.75
May	25,130	18.85	14,520	10.89
June	30,467	22.72	15,102	11.63
Total	525,522	402.09	370,787	282.60
Average	21,896	16.75	15,449	11.77

Months	System: V-shaped, Daily: Latex	Daily: Dry rubber	Alternate daily: Latex	Alternate daily: Dry rubber	Opposite V's, Daily: Latex	Daily: Dry rubber
1926	*Cu. cm.*	*Pounds*	*Cu. cm.*	*Pounds*	*Cu. cm.*	*Pounds*
July	87,812	69.35	45,704	36.09	[a]	[a]
August	32,944	25.07	37,934	28.87	[a]	[a]
September	14,867	10.95	15,103	11.13	[a]	[a]
October	13,444	10.79	14,108	11.32	[a]	[a]
November	8,280	6.28	9,725	7.38	[a]	[a]
December	5,364	3.91	5,006	3.65	[a]	[a]
1927						
January	9,564	6.83	7,269	5.19	14,072	10.06
February	14,780	10.76	3,311	2.41	43,261	24.94
March	21,187	16.59	2,403	1.88	24,518	19.20
April	24,437	18.27	1,534	1.14	18,752	14.02
May	31,207	23.34	1,897	1.41	19,830	14.83
June	13,999	10.48	3,385	2.53	24,637	18.47
July	32,357	24.22	6,286	4.71	24,235	18.19
August	22,960	19.91	[b]	[b]	12,754	9.07
September	13,718	12.57	[b]	[b]	11,776	10.79
October	14,751	11.94	3,787	3.06	12,366	10.01
November	16,703	11.31	8,435	5.49	16,613	11.25
December	28,012	18.54	16,781	11.11	31,030	20.54

[a] Not yet started

[b] Rested due to disease

TABLE III—Continued

Months	System					
	V-shaped				Opposite V's	
	Daily		Alternate daily		Daily	
	Latex	Dry rubber	Latex	Dry rubber	Latex	Dry rubber
1928	*Cu. cm.*	*Pounds*	*Cu. cm.*	*Pounds*	*Cu. cm.*	*Pounds*
January	16,887	11.96	7,610	5.49	25,212	18.14
February	12,550	9.58	5,081	3.87	15,985	12.20
March	25,760	20.51	14,905	11.86	25,631	21.18
April	27,205	20.28	11,399	12.90	25,348	18.90
May	31,978	23.98	16,079	12.06	33,323	24.99
June	36,196	25.87	10,043	15.09	36,289	26.53
Total	556,962	423.29	247,785	198.64	406,632	285.12
Average	23,206	17.63	11,663	9.02	17,776	15.84

General average for the daily section.... 20,959 cu. cm. = 16.74 pounds
General average for the alternate daily section.... 13,556 cu. cm. = 10.39 pounds

It was found that the greatest yield was obtained during the months of July, August, and June, at which period the trees were in their fruiting stage. The least production was obtained in November, January, and December, during which time the trees were in their wintering period.

The general average monthly yield of the daily section was 21,292 cubic centimeters of latex, equivalent to 16.74 pounds; and that of the alternate daily section, 12,886 cubic centimeters of latex, equivalent to 10.02 pounds.

The alternate daily section in which the V-shaped method was followed was rested during August and September, 1927, because most of the trees gave very little or no yield and what there was coagulated so quickly that it would not flow into the collecting cups. Upon examination it was found that nearly all the trees were affected with the brown-bast disease while some had the die-back. The damp and low situation of the place from which the water does not drain quickly is supposed to be the cause for the occurrence of these diseases.

TABLE IV

System	Number of days actually tapped	Total actual production		Average yield per tree	
				Per day	
		Latex	Dry rubber	Latex	Dry rubber
		Cu. cm.	*Pounds*	*Cu. cm.*	*Pounds*
Half-spiral (daily)	577	525,522	402.09	23.92	.018
Half-spiral (alternate daily)	259	370,787	282.60	37.67	.028
V-shaped (daily)	574	556,962	423.29	24.25	.018
V-shaped (alternate daily)	249	247,785	198.64	26.89	.021
Opposite V's (daily)	424	406,632	285.12	27.99	.019
Total	2,083	2,107,688	1,591.74	140.72	0.104
Average	416.6	421,537	318.34	28.14	0.020

System	Per year[1]		Yield per acre in dry rubber[2]	Average yield of the daily and alternate daily sections	Average girth measurement
	Latex	Dry rubber			
	Cu. cm.	*Pounds*	*Pounds*	*Pounds*	*Inches*
Half-spiral (daily)	4,353.44	3.276	327.60	418.60	28.56
Half-spiral (alternate daily)	6,855.94	5.096	509.60		31.88
V-shaped (daily)	4,413.50	3.276	327.60	354.90	21.93
V-shaped (alternate daily)	4,893.98	3.822	382.20		18.61
Opposite V's (daily)	5,094.18	3.458	345.80	345.80	26.58
Total	25,611.04	18.938	1,893.80	1,119.30	127.56
Average	5,122.2	3.787	378.70	373.10	25.51

[1] Considering 182 as the number of tapping days per year.
[2] Considering 100 trees per acre.

Table IV shows the actual number of tapping days, actual total production, average girth measurement and the comparative yield by the different systems of tapping reduced to the yield per tree per day and per year per acre.[1] The totals and their corresponding averages are also given.

The total actual production by the three systems during the entire period was 2,107,668 cubic centimeters of latex equivalent to 1,591.74 pounds of dry rubber (cup washings and tree scrap included) or 34.32 per cent of the total latex.

The average yield per tree per day was 28.14 cubic centimeters of latex equivalent to 0.020 pound dry rubber or 5,122.2 cubic centimeters latex equivalent to 3.787 pounds of dry rubber per year. The average yield per acre of 100 trees in Baco, Mindoro, therefore was 378.70 pounds.

Comparing the total average yield obtained by the three systems when tapped daily and alternate daily on the per acre basis, it will be seen that the half-spiral, which yielded 418.60

[1] Acre=.4047 hectare.

pounds of dry rubber, gave the highest production, followed in order by the V-shaped and opposite V's, which gave 354.90 pounds and 345.80 pounds of dry rubber, respectively.

SUMMARY

1. During the course of the experiment it was observed that higher yields were obtained during the months of June, July, and August and lower yields during November, December, and January.

2. The average yield for the daily section, based upon the total actual production during the entire period covered by the experiment was 16.74 pounds of dry rubber and 10.39 pounds of dry rubber for the alternate daily section.

3. The yields computed per acre, by the three systems of tapping are 418.60 pounds of dry rubber for the half-spiral system, 354.90 pounds for the V-shaped and 345.80 pounds for the opposite V's.

4. The average yield computed per acre per year, based upon the total actual production of the three systems of tapping tested was 378.70 pounds of dry rubber.

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PRELIMINARY PARTIAL SHADE TESTS WITH WRAPPER TOBACCO IN THE COTABATO VALLEY

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This report aims to present the results of preliminary tests, using young coconuts and *Tephrosia candida* for partial shading for the production of cigar wrapper tobacco. The first experiment under coconuts and the second under *Tephrosia candida* were carried out in Pikit in the 1921–22 and 1923–24 seasons, respectively; the third using the second plant was carried out in the 1926–27 season at Sarunayan.

The value of artificial shading to tobacco fields for the production of cigar wrappers, is a well-known. The most common materials being used at present are cheesecloth in the Connecticut Valley, Cuba, and Porto Rico; wooden lath frames in Florida; and palm leaves in Cuba also. Artificial shading, however, involves a heavy outlay of money and to save this expense but at the same time get as much of the benefits that come from the practice of shading as possible, the use of living plants for partial shading was tried in the Cotabato Valley.

Stewart, as quoted by Paguirigan(2), claimed that the use of artificial shade for tobacco was accidentally discovered in Florida with tobacco grown in new fields where some trees had been left standing for lack of time to fell them. These shaded the plants and the result was the production of superior wrappers. The other instance known whereby living plants were used to furnish partial shade for tobacco was during the 1920–1921 tobacco season at the Dammao Tobacco Station of the Bureau of Agriculture(1). The plants used, however, were maize and cassava but because of typhoons, the experiment was discontinued there.

This report about interplanting tobacco in a young coconut grove, and trying to use *Tephrosia candida* to give the shade, simulating the shade given by young trees, and all other papers

the author has written to call attention to the great possibilities of the Cotabato Valley in the growing of wrapper tobacco.

The objects of these tests were: (1) to find out if cigar wrapper tobacco can be interplanted to advantage with young coconuts, the common permanent crop in the Cotabato Valley, and *Tephrosia candida,* (2) whether this shade-grown crop has an advantage in wrapper qualities and in quantity over the sun-grown, and (3) what cropping system can be recommended as a result of these tests.

FIRST TRIAL

1921–22 TOBACCO SEASON AT PIKIT. SHADE PLANTS, YOUNG COCONUT TREES

A young coconut plantation three years old occupying an area af 6,393 square meters that was interplanted with rice and corn for the first year, but neglected for two years up to the time of the experiment, was used. During the two years of neglect the young plantation was overrun by talahib, cogon, and other grasses and weeds.

An adjoining piece of land, 2,483 square meters which had about the same soil conditions and the same grasses and weeds as those growing with the coconuts was used for check plots.

Both plots were tractor plowed and disc harrowed. After the grass roots were sufficiently dried out or decayed, the land was again plowed by animal power. Both plots were laid out in rows 1 meter apart and the rows were ridged sufficiently high to insure perfect drainage. This ridging was done ahead of the transplanting.

Due to the different sizes of the plots and the lack of sufficient seed of certain varieties used, it was not possible to make the area devoted for each variety of equal size.

Three varieties of tobacco were used, namely: P. I. 8714 Philippine Florida-Sumatra, P. I. 8587 Philippine Sumatra, and P. I. 8711 Havana wrapper.

The seeds were sown in sterilized beds beginning October 1, pricked 7 centimeters by 7 centimeters into fresh unsterilized beds beginning October 17 and transplanting was started November 16 and completed December 21.

On the ridges the seedlings were transplanted 50 centimeters apart.

About the end of the year there was a dry spell, the rain record for December being only 43.9 millimeters. It was nec-

essary, therefore, to water the seedlings from December 31 to January 3.

The cultures both under the coconuts and in the open were given uniformly good care. The insects were picked off, weeds removed, and the small leaves and suckers pinched off and buried in the ridges immediately around the stems of the plants.

With the exception of the mother plants for seed production, the plants were topped when they started to bloom.

Harvesting of all the plots was started January 7 and continued throughout the month of February.

Curing the leaves was done in a curing shed 14 meters by 7 meters and inside care was taken not to hang partially dried leaves on the racks with the green leaves. All the poles with partially dried leaves were pushed to one end of the shed.

The results from the cultures may be tabulated as follows:

TABLE I.—*Results of the first trial, at Pikit, under young coconuts*

Variety	Area[1]	Total yield	Wrappers	Calculated yield per hectare	Remarks on the wrapper leaves
		Shade culture			
	Sq. meters	*Kilos*	*Per cent*	*Kilos*	
P. I. 8714 Philippine Florida-Sumatra.	4,757	560	45	1,177	Thin, uniform color, elastic.
P. I. 8587 Philippine Sumatra.	1,463	138	50	943	Thin, uniform color, very elastic.
P. I. 8711 Havana Wrapper.	173	13	20	751	Medium fine, not very elastic.
		Open culture			
Variety	Area	Total yield	Wrappers	Calculated yield per hectare	Remarks on the wrapper leaves
	Sq. meters	*Kilos*	*Per cent*	*Kilos*	
P. I. 8714 Philippine Florida-Sumatra.	2,200	271	35	1,227	Thin, elastic, darker colors than in the shade.
P. I. 8587 Philippine Sumatra.	170	20	25	1,176	Thin, not so elastic, colorado claro color.
P. I. 8711 Havana Wrapper.	113	9.5	10	840	Medium in fineness, dark color

[1] Land actually occupied by the tobacco, allowances being made for that occupied by the coconuts.

SECOND TRIAL

1923–24 TOBACCO SEASON AT PIKIT. SHADE PLANTS, TEPHROSIA CANDIDA

A piece of land 7,036 square meters, which was in grass and weeds and had been planted to tobacco for two seasons pre-

viously, was used. The land was cleared and plowed twice during June. On the 28th and 29th of the same month, *Tephrosia candida* seeds were drilled in rows 4.5 meters apart, running from north to south. The land was cultivated twice with a small-toothed cultivator while the *Tephrosia* was growing.

Tephrosia candida is a rapid-growing leguminous shrub that attains 4 meters in height when fully developed and may live for about 4 years. It can be easily pruned. The idea of the use of *Tephrosia* is to simulate the shade given by certain young trees.

An adjoining piece of land was not planted to *Tephrosia* but reserved for check plots.

On October 1, seeds of the following varieties were sown in sterilized seedbeds: P. I. 8587 Philippine Sumatra, P. I. 8293 Philippine Sumatra No. 1, P. I. 8294 Philippine Sumatra No. 2, P. I. 8714 Philippine Florida-Sumatra, and P. I. 8591 Bx-hybrid.

Pricking the seedlings into fresh unsterilized beds 1 meter by 8 meters was started on October 17, and continued to the end of the month.

Between November 15 and the end of the month the transplanting was rapidly done.

The spacing used for all the varieties except the Philippine Florida-Sumatra was 40 centimeters by 80 centimeters, permitting five rows to be laid between the *Tephrosia* rows; for Philippine Florida-Sumatra the distances used were 90 centimeters by 50 centimeters making it possible to plant four rows only between two *Tephrosia* rows.

In the middle of December and at the beginning of January cultivation between the rows was done by using alternately the same day a small-toothed and large-toothed cultivator in order to raise the ridges. In order to round off the apices of the ridges the soil was piled up by hand labor.

Harvesting by priming was started December 31 for the sand leaves and was carried on to the end of February.

The tobacco was cured in a shed of the same size as that described in the account of the first trial.

The check plots were simply the extended rows beyond the *Tephrosia* to the reserved open area. Unfortunately the check cultures failed to give satisfactory results as the plants were abnormally stunted in growth. This was due to hasty prepa-

ration of the ground and the lack of moisture during their development, the total rainfall for December being only 68.9 millimeters and for January, 27.4 millimeters. The tobacco under the *Tephrosia* did not suffer very much in this respect, as the ground was more moist than in the open.

The results of this second trial of growing tobacco under a new shade plant may be seen in Table II.

TABLE II.—*Results of second trial, under Tephrosia candida*

Variety	Area [1]	Total yield	Wrappers	Calculated yield per hectare	Remarks on the wrapper leaves
	Sq. meters	*Kilos*	*Per cent*	*Kilos*	
P. I. 8587 Phil. Sumatra	4,095	147.3	45.6	369.7	Very fine, silky, and light colored
P. I. 8293 Phil. Sumatra No. 1.	826	66.1	39.7	800.0	Very fine, silky, and light colored
P. I. 8294 Phil. Sumatra No. 2.	826	58.4	28.6	707.0	Fairly fine.
P. I. 8591 Bx-hybrid	463	29.4	27.1	635.0	Very fine, large, light colored leaves.
P. I. 8714 Phil. Florida-Sumatra.	826	69.6	31.0	830.0	Fine, uniform color, very elastic.

[1] This area included the land occupied by the *Tephrosia* which was approximately one-ninth of the whole area; the yield calculated per hectare for each variety was therefore less by one-ninth.

The results obtained in the check plots have not been placed with the shade grown results appearing in Table II, because for the reasons stated above, conditions were abnormal in these plots. What the varieties tested might do under normal conditions of growth is not known.

Since the shade-grown tobacco gave us the best wrapper leaves, it would be fairer to compare the shade-planting results with our best cultures in the open with the same varieties in nearby plots and grown during the same season.

TABLE III.—*Results of trials with the same varieties when grown in the open*

Variety	Area	Total yield	Wrappers	Calculated yield per hectare	Remarks on the wrapper leaves
	Sq. meters	*Kilos*	*Per cent*	*Kilos*	
P. I. 8587 Phil. Sumatra	1,000	121.7	24.0	1,217	Very fine, colorado claro.
P. I. 8293 Phil. Sumatra No. 1.	683	67	24.2	981	Fairly fine.
P. I. 8294 Phil. Sumatra No. 2.	472	35.5	16.6	756	Fairly fine, colorado claro.
P. I. 8591 Bx-hybrid	740	129	22.1	1,600	Large, fairly fine leaves, claro color.
P. I. 8714 Phil. Florida-Sumatra.	657	42.9	20.9	525	Large fine leaves, thick veins.

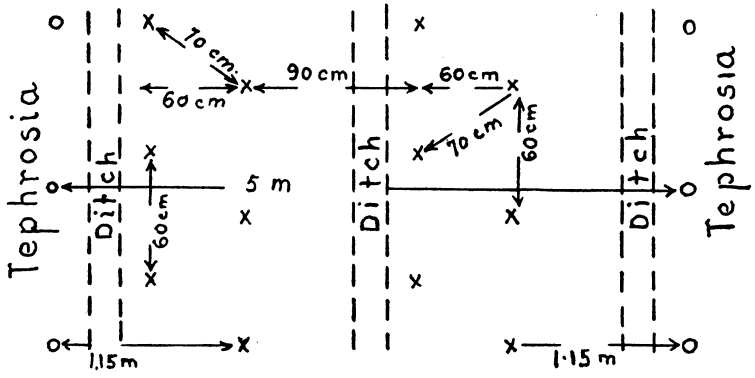
THIRD TRIAL

1926–27 TOBACCO SEASON, AT SARUNAYAN. SHADE PLANTS, TEPHROSIA CANDIDA

A hectare that had previously been planted to *Tephrosia* was used for the experiment. The *Tephrosia* was planted in rows 5 meters apart with the seeds sown in drills over a year before the experiment took place. The shade being very dense, the *Tephrosia* was thinned, leaving one-half meter between plants in the row. Another piece of land containing 2,000 square meters separated from the *Tephrosia* field by a road was used as a check plot.

Seeds of the variety P. I. 8587 Philippine Sumatra were sown in beds September 16, and another lot of seeds was sown on October 1.

From October 12 to the end of the month pricking of the seedlings into fresh beds 1 meter by 16 meters was done and from November 8 to 30 the transplanting in both plots. In the check plots, the distance used was 80 centimeters by 40 centimeters. Only four rows of tobacco were planted between two rows of *Tephrosia*. The method of planting was the Sumatra (3) alternate short and distant row method with the plants laid in triangles. The distant rows were 90 centimeters apart; the close rows 60 centimeters apart, and the plants of one row were 70 centimeters from the plants of the nearest row, as per the following diagram:



Previous experience in Pikit suggested the advisability of planting only four rows, so that the rows nearest the *Tephrosia* did not receive very dense shade. Moreover, the *Tephrosia* being full grown was taller than at Pikit. Every two close

rows were ridged together forming two beds between two *Tephrosia* rows.

Three shallow ditches were thus made between two rows of the shade plants. These ditches emptied into a large ditch at the northern side of the field. Another ditch was made at the eastern side of the field to prevent the water from coming in from the higher ground outside. Had it not been for these ditches, the crop under the *Tephrosia* would have been a total failure, as there was too much rain in December and January.

Due to the wider distance allowed between the *Tephrosia* and the tobacco rows, actually two-thirds of a hectare was occupied by the tobacco.

Table IV shows the results of this trial with the variety P. I. 8587 Philippine Sumatra.

TABLE IV.—*Results of the third experiment with Tephrosia at Sarunayan*

Treatment	Area	Yield	Wrapper	Calculated yield per hectare	Remarks on the wrapper leaves
	Sq. meters	*Kilos*	*Per cent*	*Kilos*	
Shade grown	6,666	290.6	60.0	425.9	Very fine, elastic, and mostly claro.
Check	2,000	172.8	29.3	864	Fairly fine, inclined to be colorado claro.

OBSERVATIONS AND DISCUSSION OF RESULTS

The 1922 crop was so far the best obtained by the station and our best wrapper leaves came from the tobacco grown under coconuts. The 1924 crop was the second best. According to the Tabacalera report some 416 cigars could be wrapped from one kilo of leaf, but it was stated that the number of cigars could be increased by protecting the tobacco plants in the field from the insect pests. The 1927 crop was not so good as the other two, but it is the best crop so far obtained at Sarunayan. Last season, the weather was very wet during the seedling and maturity stages and an unusual attack of insect pests and fungus diseases materially decreased our field for all our cultures. The leaves that were badly worm-eaten or badly attacked by fungus diseases were discarded at the harvesting time.

In all the experiments the total yield in the open cultures was higher than in the shade cultures. However, not much importance should be attached to these higher yields as thick tobacco is heavier leaf for leaf than thin tobacco.

In order to make clear the advantage of one treatment over the other in the production of fine wrapper tobacco, as the principal object in shading, the following table of the percentages of wrapper leaves is given.

TABLE V.—*Comparison of the percentages of wrapper leaves between two treatments for 3 trials*

Variety	Percentage wrappers		Difference in favor of shade-grown
	Shade-grown	Sun-grown	
FIRST TRIAL, PIKIT, 1921–22			
P. I. 8714 Philippine Florida-Sumatra	45.0	30.0	15.0
P. I. 8587 Philippine Sumatra	50.0	20.0	30.0
P. I. 8711 Havana wrapper	20.0	10.0	10.0
SECOND TRIAL, PIKIT, 1923–24			
P. I. 8587 Philippine Sumatra	45.6	24.0	21.6
P. I. 8293 Philippine Sumatra No. 1	39.7	24.2	15.5
P. I. 8294 Philippine Sumatra No. 2	28.6	16.6	12.0
P. I. 8591 Bx-hybrid	27.1	22.1	5.0
P. I. 8714 Philippine Florida-Sumatra	31.0	20.9	10.1
THIRD TRIAL, SARUNAYAN, 1925–26			
P. I. 8587 Philippine Sumatra	60.0	29.3	30.7

The percentages of wrappers appear low. This is because what we consider wrappers in the station are those fine leaves that are marketable and can be actually used for wrapping cigars. In this way an appreciable quantity of fine leaves that are very badly worm-eaten, broken in handling, or with too many blemishes caused by fungus infestations, are not included in these percentages. The medium fine leaves that can be used for wrapping low-priced cigars are considered binders and do not come within the wrapper class in this strict classification.

In every case the shade-grown tobacco gave more wrappers than the sun-grown. The difference varied from 5 per cent for P. I. 8591 Bx-hybrid to 30.7 per cent for P. I. 8587 Philippine Sumatra. Expressed in another way, the shade-grown produced from one-fifth to twice as much more wrappers than the sun-grown produced, the tendency being the doubling of the wrapper produced.

Observations of the cultures showed one important fact which does not speak very highly of living plants for shading purposes.

The development of the tobacco plants was uneven; the plants and rows very close to the coconut plants and the *Tephrosia* rows were smaller than those in the middle because of different degrees of exposure to the sun, the tobacco plants and rows immediately close to the shade plants receiving too dense shade for normal development. The leaves produced by these rows were smaller but thinner. The roots of the coconuts and the fact that the soil reached by them may be poorer were small contributory causes for this uneven development. The coconuts were more satisfactory than the *Tephrosia* in this respect. It may also be remarked here, in passing, that the cured leaves of plants close to the coconuts had a very slight flavor of coconut when smoked.

This uneven development was the cause of some of the very low yields obtained under shade when the season was normal.

Herein lies the superiority of the cloth tents, lattice work of laths, and palm leaves for shading tobacco over living plants in that the shade, particularly of the cloth tent, is very uniform. Moreover the utilization of the land is complete and with cloth tents the ravages of insects are under better control. With these advantages in favor of these materials, it stands to reason that should they be tried in the Cotabato Valley, the results will be far more satisfactory. The only question is whether the use of cloth tents would be as profitable as generally is the case in the advanced tobacco regions. The matter of profit would depend very much upon the reputation of the Cotabato wrapper, and this, in turn, would depend upon the proper development here of this highly specialized industry.

Young coconuts were used because they are the principal permanent crop. Many of the young coconuts here die before they become of bearing age due to weakness brought about by the ill-effects of the cogon roots and if that is not enough there are grass fires to finish them. The cleaning and cultivation of the abandoned tobacco plantation would materially help the growth of the young grove. In the case of this experiment the coconuts developed so well during the planting of the tobacco that an attempt to raise a second crop of tobacco the following season failed due to the dense shade. Since only the leaves are taken from the tobacco, leaving the stems and other parts of the plants in the place, the fertility of the soil is not exhausted thereby, as the wrapper leaves are of small

size and so do not take too much plant food from the soil, it is believed. Unfortunately, no analysis of the wrapper leaves produced during these tests was made. It may be interesting to quote here the analysis of leaves of shade-grown Havana tobacco, as reported by Paguirigan(4) in the Philippine Agricultural Review in 1923 as follows:

Properties	Per cent
Moisture	11.00
Phosphoric acid	0.77
Nitrogen	4.18
Potash	2.34
Crude ash	17.83

The average yield for all these tests for all varieties is 737.4 kilos per hectare. Judging from these figures, the soil fertility removed per hectare of shade-grown tobacco is approximately 5.8 kilos of phosphoric acid, 30.8 kilos of nitrogen, and 17.3 kilos of potash. Even doubling these figures to include the composition of the stalks and assuming that the analysis of our tobacco would show slightly higher figures than these, the wrapper tobacco crop cannot easily exhaust the fertility of our rich soil. The cultivation for the tobacco turned out beneficial to the grove. The most rational cropping method would be to have the tobacco followed by a legume crop, such as patani or palauan beans.

RUBBER AND TOBACCO CROPPING SCHEME SUGGESTED

As stated elsewhere *Tephrosia candida* was planted to simulate the shade produced by young trees. The most important deduction from this seems to be that instead of using *Tephrosia*, young Para rubber trees, 2 to 3 years of age from transplanting, might be planted to provide shade that is not so dense. In Sumatra forest land is cleared and cultivated laboriously by hand for a crop of wrapper tobacco once in 7 or 8 years, the land thereafter being left to return to jungle. Why could we not in the Cotabato Valley follow the tobacco with rubber or coconuts interplanted with perennial legumes? The advisability of this cropping seems apparent. The production of wrapper tobacco entails heavy expenses, but leaves the land in good tilth so it could be easily planted to a permanent crop and a leguminous crop with no more work than pulling the tobacco stems and laying them in rows. Moreover, should the weather conditions be disadvantageous for the wrapper crop, part of the

expenses could be charged to the permanent crop, and be recovered later. The scheme of cropping would be somewhat like the following: wrapper tobacco followed immediately by rubber with a perennial legume as cover crop. Parenthetically, it may be mentioned that the end of the tobacco season here is the beginning of the rainy season so advantageous for transplanting rubber. When the rubber plantation needs some soil stirring, this may be done in its second or third year and the land planted to tobacco again. The tobacco can then be followed by a legume. From this time on, no more tobacco should be planted in the rubber plantation. Concretely, then, the rubber land will have two crops of wrapper tobacco—one just preceding the setting out of the trees and another shade-grown—and two crops of perennial legumes following each crop of tobacco for returning the nitrogen removed and for cover cropping the young rubber trees.

CONCLUSIONS

1. Cigar wrapper tobacco can be grown successfully under young coconuts and *Tephrosia candida* in the Cotabato Valley. It is to be inferred from these results that other permanent crops, such as Para rubber, bananas, kapok, and young trees of a single species in a block that do not give very dense shade, may be used. In worn-out cogon lands, *Tephrosia candida* and ipil-ipil, *Leucaena glauca,* may be planted to give nitrogen to the soil and provide shade for the tobacco.

2. In every case the shade-grown tobacco produced a greater percentage of wrapper leaves than the sun-grown; the tendency being the doubling of the wrapper yield. The shade-grown wrapper leaves were of more even texture, more uniform and lighter in color, more elastic, and silky than the sun-grown. A second inference may be drawn: Imperfect and non-uniform as the shading of the tobacco was with these living plants and uneconomical the utilization of the land, it showed that growing tobacco under cloth tents may still give more remarkable results than these tests.

3. Judging from the development of the coconuts after the tobacco crop, and the fact that wrapper tobacco removes but little fertility from the soil, a cropping system, as outlined above, might advantageously be tried here, perhaps, with special attention to Para rubber as the permanent crop, and wrapper tobacco as the temporary crop.

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AGRICULTURAL CREDIT IN THE PHILIPPINES IN ITS DIFFERENT STAGES [1]

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INTRODUCTION

In any country where economic development has not as yet reached its full height, credit seems to be the slogan of everybody. Where there is any need for social betterment and a real desire for material improvement, credit appears to be the keyword which helps anybody solve the intricate problem of financing any enterprise.

The term "credit" is used with a great variety of meanings. A man is said to have good credit if he has the reputation among his business associates of paying his debts promptly when due. Credit, therefore, may be broadly defined as "the power to get goods in exchange by giving a promise or contract to deliver an equivalent at some future time." In short, credit is a promise to pay.

The most important service of credit is to facilitate the transfer of capital and thus to promote the production of wealth. But it must be understood that credit is not itself either capital or wealth. Wealth consists of economic goods and capital consists of economic goods used in the production of wealth. Now, credit is not a thing or commodity, nor does it create anything. No more wealth, no more capital, no more goods exist after credit is given than before. If capital is in the hands of the borrowers, it is withdrawn from the lender. Credit, then, is merely the agency of transfer.

Credit may be classified in a variety of ways. A common serviceable classification divides credit into five kinds: personal, commercial or mercantile, banking, public and investment, and agricultural credit.

Since my purpose is not to discuss credit in general, I will confine my study to that which vitally concerns us: agricultural credit.

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[1] This paper was read at the College of Agriculture, University of the Philippines, Agricultural College, Laguna, February 3, 1928. This is part of a bulletin under preparation entitled "A Philippine Rural Credit Primer."

AGRICULTURAL CREDIT DURING PRE-SPANISH ERA

Agricultural credit is an old institution in the Philippine Islands, perhaps older than the most elemental banking system, as it was known before currency was used as a means of trade and commerce.

In olden times, when every able-bodied man was the owner of the lands he tilled because private ownership was not yet systematically regulated, credit was first conceived by the human mind as a necessity. From that immemorial epoch confidence was known and accepted as the only basis of contracts. No document was drawn nor was any public or private instrument needed to perfect a contract of debt between the lender and the borrower. The peddler trusted his goods to the farmer on the security of the latter's good faith and the reliability of his word. Human greed in those times was not yet rampant so everybody, the lender as well as the borrower, trusted that both parties would keep their words, as in fact they did.

The early merchants who came to the Islands and established trade relations with the inhabitants, were possibly the first to introduce the credit system in our business relations. They advanced goods to their customers, mostly farmers who lived in the valleys and in the foothills who once a week used to come to the town to buy foodstuffs on credit, and the next week bring chickens, vegetables and other crops they had raised to pay for what they owed or to exchange for what they needed. Thus credit was practically instituted in our farm life.

When trade relations were established in these Islands with those coming from other countries, the use of currency was known, and then the idea of obtaining goods on credit was reformed and the granting of loans in money began to be the custom. In all these credit transactions, however, the only basis was the confidence which the lender had in the borrower, and the reputation that the borrower had of paying his debts punctually.

The people began to acquire lands by occupation, not only to build their homes, but also to produce more crops and to save money for their future necessities. It was but natural that the more enlightened ones, especially those who had by inheritance or by force acquired some power to control others, should possess large tracts of lands; and then the tenantry system was little by little started, improved, developed to its worst stage, and made use of to oppress the unfortunate.

THE TENANTRY SYSTEM

The system of tenantry is founded upon custom. The custom did not originate in the Philippines. It is a custom that is older than the Biblical maxim, "To him that hath shall be given and from him that hath not shall be taken away even that which he hath." And probably accounts for that maxim.

Under the present tenantry system in the Philippine Islands, in relation to the credit transactions which the tenants have to enter into with their landlords, the tenant has no chance to get ahead of the game unless he is given a larger share of the crop than he produces or unless usury and "gouging" are eliminated.

This system created and made into custom the application of certain usurious methods that for many years have been sanctioned by the natural indolence of our people. The tenantry system added to our vocabulary the following words and phrases which became generalized afterwards: *pasunod, takalanan, kabig, talindua, takipan, baligtaran, medyang-palabasan, pamatá,* etc.

These Tagalog expressions have peculiar meanings and applications, as may be seen from the following definitions:

PASUNOD

Meaning: Something to follow with or to send along. This word applies to certain compulsory loans given by the landlord in advance to the tenants either in cash, merchandise, clothing or jewelry or other commodities. The tenants have to take what is offered as a loan, regardless of whether they want it or not upon starting work on the landlord's property.

The abuse committed by landlords in connection with this custom consists in charging the tenants a high price for the merchandise or commodity thus loaned which has to be paid back in agricultural products at the time of harvesting.

TAKALANAN

Meaning: The root is "takal"—to measure grain. "Takalanan" means to pay certain debts with agricultural products at harvest time.

When the tenant receives a "pasunod" from his landlord, the former has to pay it back in grain to the latter, when the crop is divided, the price having already been fixed at the time of contracting the debt, or according to conditions in the locality. If the tenant should receive a "pasunod" of say, twenty pesos upon commencing on the land of his landlord, an agreement would be entered into to the effect that the payment would be ten cavanes.

The "takalanan" system is also in vogue, not only in the commercial relations between landlord and tenant, but also between merchant and farmer, or middleman and grower, or in any case where the debtor is a producer and the creditor a money lender.

KABIG

Meaning: To take for oneself, or to get what is due one. If "pasunod" is a compulsory loan, "kabig" is a compulsory payment. Whenever the word "kabig" is used in any contract, it means that the debtor will allow the creditor to separate from the gross income or whole crop that portion which would pay for the debt contracted before under the "pasunod" system or for any ordinary loans made.

"Kabig" is known under two typical denominations:

"Kabig sa kuarta" means that the landlord is permitted to take his due from the proceeds of the sale of the products grown by the debtor at the time such crop is sold.

"Kabig sa palay" means that the landlord is authorized to take from the portion which might pertain to the tenant that part of the whole crop before same is sold, to apply to the debt of the tenant.

TALINDUA

Meaning: Contraction of two words "tatlo" and "dalawa" (three and two).

"Talindua" is the manner of paying a debt at the rate of three for two, that is, if the tenant owed ten, he would pay ten and five or 50 per cent more than the capital. This applies to all kinds of debts, either in grain or in cash.

TAKIPAN

Meaning: Covering each other or duplicating the number.

It is a more onerous manner of paying than the "talindua," for the reason that the rate becomes 100 per cent of the debt,—that is, if the tenant owed ten pesos, he would pay ten pesos plus another ten pesos as interest on the money. This also applies to all kinds of debts, either in grain or in cash.

BALIGTARAN

Meaning: Converting, or a queer mathematical process applied in the computation of the debt and the conversion of same from money into grain or vice versa.

The "baligtaran" process is now becoming obsolete, but it has prevailed a long time in the provinces of Bulacan and Nueva Ecija. The procedure is as follows:

Supposing that A (tenant) receives a "pasunod" or an ordinary loan of ₱50 to buy a carabao from B (landlord) which is to be paid in "takipan" or ₱100 in the harvest season, this will be paid in grain according to the "takalanan" system at the rate of two pesos a cavan or 50 cavanes.

At the harvest season, according to the process of "kabig sa palay," B will separate from the portion which corresponds to the tenant the fifty cavanes with which to pay his debt, but if the crop obtained from the land is not sufficient to pay said debt the unpaid balance will be converted into grain and valued according to the market value, say three pesos a cavan.

Supposing that A could pay back only thirty cavanes, then he would still owe 20 cavanes. These 20 cavanes valued at ₱3 a cavan, will be regarded as ₱60, which will again be converted into an ordinary loan payable at the next harvest season at the rate of ₱2 a cavan, and sometimes ₱1.50.

The balance will again be converted into grain, and then into money, and so on, until the tenant will be stuck in the quagmire of debt forever, and the landlord may be assured of getting all the crops of his lands without giving the tenant any share of his produce.

To see how a "pasunod" of one peso will grow if not paid in three years the following is given:

Debt contracted in 1905..... ₱1.00
To be paid in "takipan" it automatically becomes..... ₱2.00

At the harvest season it should be paid with ONE CAVAN of palay, but if not paid will be converted into money, according to the "baligtaran" process at the rate of ₱3 which will have to be paid in takipan, or at the beginning of the second year the tenant will owe ₱6.

To be paid in products which equal THREE CAVANES.

These three cavanes, if not paid at the harvest season, automatically become money at the rate of ₱3 or ₱9 which will again have to be paid in takipan or ₱18.

This is what the debtor owes at the beginning of the third year. And think what it means in 10 years or more!

MEDYANG–PALABASAN

Meaning: A grain measure which equals one-half cavan used in lending any kind of grains, either as husked rice, palay or corn.

The abuse in this scheme consists in using a larger measure in collecting than that which is used in lending. Petroleum boxes are often used instead of the legal one-half cavan measure.

PAMATA

Meaning: For the eye, or a certain payment made by the tenant in advance to the landlord so that the former may work on the land of the latter. Most tenants pay "pamata" to the owners of good lands, simply to be allowed to become their tenants. In fact, this is a charge made by the landowner to his tenants if he has first-class agricultural lands so as to compel the tenants to work on poor land.

USURY

Our study of this subject would be incomplete if we should not mention the severest of all evils in all social relations. I mean "usury." The question of usury is by no means a new one. It is almost as old as the human race, certainly as old as any financial system. In earlier periods of history, interest—payment for the use of money—and usury—payment in excess of the rate allowed by law—were used as synonymous terms, and any attempt to extract a fee for the use of a loan was looked upon as immoral. Solon, archon of ancient Athens, forbade it by law, a mandate which Socrates and Plato later endorsed on ethical grounds. In mediaeval England, as late as the thirteenth century, Parliament made all payments for the use of money illegal.

The impracticability of doing away with interest entirely by means of legislation has been commonly apparent, however, wherever attempted, and legislative bodies have for the most part given consideration to the question of the establishment and enforcement of fair and practical rates for loans rather than to measures for their complete suppression. That this question should be, as it is, one of universal interest is in itself indicative of the abuses to which the borrower everywhere has been subjected during many generations by the unscrupulous money lenders.

Possibly no other phase of human activity has suffered as much from the evils of usury as agriculture, because farmers have only two ways of obtaining the additional capital for their agricultural ventures and for securing capital for the equipment of their farms. One is to accumulate it themselves, by consuming less than they produce; the other is to borrow it.

To obtain money from a money lender, the farmer has to submit to all kinds of exactions. The different contracts drawn for this purpose are cautiously disguised, in order to appear legal, though in fact they are no less immoral than the immorality itself. With the view to inform those who ignore their various shapes and forms, Mr. M. V. Gallego related in his graduation thesis the different kinds of usurious contracts covered with the cloak of legality, as follows:

(*a*) *Deed of sale with the right of repurchase.*—The most universal form of contract employed by usurers to evade the law is this simulated sale with the right to repurchase. The document evidencing the debt is usually made before a notary public, especially when it involves a large amount; but it is drafted in such a way that the usurious interest is made to appear in the form of rent, either in money or in agricultural products as grain, varying from 20 per cent up to 100 per cent sometimes. Long before the passage of the Usury Law, our Supreme Court had always held that in every case where it could be shown that no sale could be shown; that no sale was intended, but simply a disguised loan, the transaction was to be considered nothing more than a mortgage. The inadequacy of consideration and the condition of the debtor was found at the time of the agreement to serve as a guide to the court in determining the true intent of the parties. According to the personal observation of the writer, more than 75 per cent of the total amount of money involved in usurious transactions is covered under this form of agreement, for the *pacto de retro* is always resorted to in large scale loans. In the native province of the writer there is a capitalist in a big town who loans as much as ₱50,000 a year under usurious *pactos de retro*. It does not require a far-sighted mind or a mathematical genius to estimate how much such a capitalist would earn during his lifetime if his illegal acts should remain unchecked. Add to this the number of such capitalists found in the different towns of the Islands

and you will have before you a graphic picture of the magnitude of the contribution of this contract in nourishing the social cancer called usury. It is to be noted, however, that big capitalists usually content themselves with loaning at a lower rate of usurious interest than ordinary lenders, for taken as a whole, their net gain is much more than that of the latter class. The work of the *pacto de retro* does not end with its use as a cloak to cover usury. It goes even further than that; it is also a means to escape payment of the internal revenue tax imposed upon those who habitually engage in loaning money.

(*b*) *Mortgage secured by real property.*—A loan secured by mortgage of real property is another but less common form of contract resorted to by usurers. The interest is sometimes deducted in advance from the capital and at other times added to it; but in either case the rate of interest charged does not appear on the face of the written contract. On the contrary, it appears that there is no interest at all, but in reality the rate varies from 20 per cent to 50 per cent. This kind of contract is used only when the debtor refuses to have his land sold with the right to repurchase. To clarify the matter let me cite an example. A, the borrower, approaches B, a capitalist, explaining to the latter his great need of money. B then asks A what security he (A) has to offer for the loan, and usually A has some documents or title of some real property with him for he knows that he would have a hard time to get what he needs without security. B afterwards examines the document and if he finds it satisfactory, he will proceed to ask how much A needs. The capitalist will then say that the contract is to be in the form of a *pacto de retro*, but if the borrower is reluctant to accept the proposition the lender will halt for a moment and then continue: "Do not tell others that your loan is only secured by a mortgage for we never loan money if not under a 'pacto' so they will envy you." Assuming that the sum loaned is ₱200 and the interest agreed upon is 25 per cent, the written instrument simply says that A owes B the sum of ₱200, if interest is paid in advance, or ₱250 as the case may be payable the next year. The description of the realty mortgage is then mentioned.

(*c*) *Pignoration of valuable papers.*—Whenever a needy person has no realty with which to secure his contemplated loan, then he brings with him a certificate of ownership of a carabao or a horse or a number of them to be given as a pledge on chattel mortgage. The animal pledged remains in the possession of the debtor and only the document evidencing the ownership is delivered to the creditor, but a separate agreement is entered into whereby the usurious rate of interest is made to appear as a payment or the lease of the services, of a carabao or other animal pledged. The rate of interest in this kind of contract is usually higher than the interest charged in case of loans secured by real property, the risk being usually greater for the animal pledged may die or be lost at any time.

(*d*) *Simple loans or promissory notes.*—In the absence of any property which can be either pledged or mortgaged, then a simple loan is resorted to. Simple loans may involve money alone, or agricultural products or seeds alone, or both. In loans of money the interest charged varies from 30 to 50 per cent. In case of seeds, the debtor is usually compelled to pay one and one-half times the original capital and in case of failure to pay at the specified time, the poor borrower is even obliged to pay double

the amount of the loan. Thus, if A for instance, borrows from B 100 cavanes of palay this year and A obliges himself to pay next year, under ordinary condition A has to return 150 cavanes then; but in case of his failure to pay at that time, B may renew the written contract and charge A 300 cavanes payable the next year. A contract of this nature was very common up to the passage of the Usury Law, but fortunately it is now less frequently resorted to. At present only small capitalists are guilty of this inhuman practice. Another prevalent form of simple loan is where the capital is in money while the interest is in agricultural products or grain—10 to 20 cavanes for every ₱100 of capital payable yearly. As in all other usurious loans already alluded to, in all of these varied forms of simple loans, the usurious interests never appear on the face of the instrument; only the total amount to be paid by the obligee or debtor is stated therein. Usury reaches its culmination under this form of contract for there being no security of any kind, exorbitant rates of interest are charged to counterbalance the great risk.

(*e*) *Purchase and sale of agricultural products.*—This form of contract denominated as purchase and sale is in reality and in essence a disguised usurious loan. This contract is usually entered into in or about the time of the planting or harvesting season when small landowners are badly in need of money and are therefore compelled to sell their crop before the proper time at the low price of from ₱1 to ₱2 a cavan only to buy again when the time comes, from the very same purchaser or from others, at a high rate varying from ₱2.50 to ₱3 per cavan. What is true of rice is also true of other crops or products such as sugar, abaca, coconut, etc.

(*f*) *Exchange of agricultural products.*—Another form of contract in vogue in the provinces is the exchange of agricultural products. Small farmers whose lands are not well adapted to the production of rice raise either sugar, corn, tobacco and similar products. Before the harvesting season, they usually lack the means of support so that they are compelled to borrow rice in time of need to be paid back later from what they produce. A cavan of rice is generally given for an amount of corn or tobacco sufficient to cover interest varying from 50 to 100 per cent. This practice is limited to places where lands are devoted to the production of different crops.

(*g*) *Fake deposits.*—A deposit is another means resorted to by the usurer to keep under cover his illegal acts. The amount of money loaned is always expressed in palay as per agreement and it is then reduced to writing. On its face the instrument makes it appear that the debtor is the depositary who obliges himself to deliver to the creditor, on a fixed date at a specified place, a certain amount of palay. The interest charged is always beyond the limits prescribed by law. Sometimes the usurer is not satisfied with charging an excessive rate of interest but goes further. Upon the failure of the debtor to pay the debt, for some reason or other, as in case of drought, the creditor brings a criminal action against the poor debtor for "estafa," since under the law it is one of the obligations of the depositary to deliver back the thing deposited by the depositor.

(*h*) *Peremptory loans.*—Another practice among usurers in the loan of money to be used for gambling where the rate of interest varying from 20 to 50 per cent is computed not annually nor even monthly but usually weekly and sometimes daily. If as I have already stated, the rate of

interest is as high as 50 per cent daily or weekly, I leave it to the reader to imagine its evil consequences. Contracts of this nature, however, are not only usurious but are expressly prohibited and unenforcible under the Gambling Law. (Act No. 1757, sec. 9.)

(*i*) *Lease of services.*—Lease of services whereby the debtor personally, or some other person in his behalf (his son or daughter), serves the creditor gratuitously in consideration of a certain sum received as a loan, is also resorted to by usurers; but courts always protect the poor under such circumstances. It is however to be regretted that although this practice is very common in the provinces, only very few cases come within the knowledge of the proper authorities and are given due consideration. So far, the writer only knows of one case decided by our Supreme Court regarding this point, where it was held that all usurious contracts are prohibited and that domestic service is always understood to be compensated and any agreement made in connection with a loan of money, whereby it is stipulated that, because of the loan such domestic services shall be absolutely gratuitous, is contrary to law and good morals. (Reyes *vs.* Alegado, 16 Phil. 499.)

(*j*) *Last resort.*—Since the passage of the Usury Law the minds of usurers have been kept busy inventing devices whereby to evade the law. Among the most common of these devices, is the taking of one note or the drafting of instruments in which the principal sum with legal interest appears in one document while the illegal excess appears in another, both of which bear different dates.

In reality, human ingenuity is limitless. It can devise innumerable ways of evading the provisions of the law, no matter how severe the law may be. Human legislation can only be counted on to lessen the power of an evil, but when an evil has already poisoned the blood of mankind and prostituted society and eaten into the human heart, it is absolutely impossible for any legislative body to stop it as it is impossible to legislate away human inclinations. Modern social workers have found that the only way of eliminating usury in all contractual relations is by stabilizing agricultural credits scientifically and systematically, to suit present conditions.

THE USE OF FARM CREDIT

Speaking of credit, everybody will agree with me that there is no magic in it. It is a powerful agency for good in the hands of those who know how to use it. It is, however, dangerous in the hands of those who do not understand it. Speaking broadly, there are probably almost as many farmers in this country who are suffering from too much credit as from too little credit. Many a farmer would be better off today if he had never had a chance to borrow money at all, or go into debt for the things which he bought. However, that is no reason why those farmers who do know how to use credit should be deprived of it.

The advantage of borrowing is that one does not have to wait so long to get possession of the tools and equipment. One can get them at once and make them produce the means of paying for themselves. Without them the farmer's production might be so low as to make it difficult ever to accumulate enough with which to buy them. With their help he may be able to pay for them, that is, to pay off the debt in a shorter time than it would take to accumulate the purchase price without them. That is the only advantage of credit in any business. But it is a great advantage to those who know how to use it.

PROPER AND IMPROPER USE OF CREDIT

Short-sighted people, however, who do not realize how inexorably the time of payment arrives, how rapidly tools wear out and have to be replaced, or who do not keep accounts in order that they may tell exactly where they stand financially will do well to avoid borrowing. Debts have to be paid with deadly certainty, and they who have not got the wherewithal when the day of reckoning arrives, become bankrupt with equal certainty.

On the other hand, there is nothing disgraceful about borrowing for productive purposes. The feeling that it is not quite respectable to go into debt has grown out of the old habit of borrowing to pay living expenses. That was regarded, perhaps rightly, as a sign of incompetency. It was then natural that men should not like to have their neighbors know that they had to borrow money. But to borrow for a genuinely productive purpose, for a purpose which will bring you in more than enough to pay off your debt, principal and interest, is creditable. It shows sagacity and courage and is not a thing to be ashamed of. But it can not be too much emphasized that the would-be borrower must calculate very carefully and be sure that it is a productive enterprise he wants the money for before he goes into debt.

OBJECTION TO THE USE OF CREDIT

The question may be asked, however, why did not the early guardians of society forbid borrowing instead of forbidding the taking of interest? The reason was that so long as the usurers were permitted to offer loans, many short-sighted people would yield to the temptation to borrow. Since the purpose for which they borrowed added nothing to their earning capacity, they were in no better position to accumulate money after they borrowed than they had been before. If they had been able to accumulate anything before, they would not have needed

money. The fact that they had not been able to accumulate anything before would be pretty conclusive proof that they would not be able to accumulate enough to pay the debt. Therefore they put themselves into the clutches of some usurer.

PRINCIPAL versus INTEREST

In the payment of a debt it is not the interest but the principal which gives the greatest trouble, except where interest rates are exorbitant. If a man borrows ₱100 for a year at ten per cent, he has to pay, at the end of the year, ₱110. If he borrows at five per cent, he has to pay ₱105. The difference is ₱5. Now, ₱5 is not to be despised. Good business consists in a large part in looking after such items as this. Nevertheless, it is only a little harder to pay ₱110 than to pay ₱105. The point is that the principal is the same in either case, and it is the principal which gives the greatest trouble.

The reason it has seemed necessary to emphasize this elementary fact is that many people seem to imagine that if interest on farm loans can be reduced from 10 per cent to 5 per cent, conditions will be made easy for the farmers. It is important that interest rates be lowered wherever it is economically possible, but it is vastly more important that farmers should learn how to pay back the principal easily. The only way to do this is to use the money borrowed in such a way as to put themselves in possession of the means of repayment. An unproductive enterprise is not a safe basis for borrowing under any conditions. In other words, it is of more importance that the enterprise in which one is engaged shall be a productive enterprise than whether the rate of interest at which one can borrow money is high or low.

IMPROVING CREDIT CONDITIONS

The point to remember therefore is that the farmers must have within their power the means to remedy these conditions themselves, though it may take careful planning and hard work. In the first place, they must disabuse their minds of the notion that tangible property such as land, furnishes the best security in the world. The business ability and character of the borrower are of even greater importance in such transactions than the value of the land he may own. Where farmers are known to be capable of paying their debts and willing to do so promptly and without legal proceedings, there credit conditions are good, because the right kind of lenders are attracted. The right kind of lenders do not like to foreclose mortgages or resort to any

form of legal procedure. They will keep away from any neighborhood where such things occur frequently, and leave the field to others less considerate. The right kind of money lender merely wants his principal back together with the stipulated rate of interest.

It must be admitted, however, that one farmer can do very little when working alone, to give his neighborhood a better financial reputation, or to attract the right kind of lenders. This is a problem which must be worked out by the whole community, or at least, by a considerable group of men.

Firm in this belief, that great man Frederick William Raiffeisen worked day and night to supply the people of Coblenz, Germany, in the distressing season of 1848, with the best means of improving their financial situation. Being moved to pity for the down-trodden poor, he organized a coöperative society for the distribution of bread and potatoes among them. The following year he founded at Flammersfeld a loan society for the support of the unprovided farmers, its members being rich philanthropists who sold cattle to unorganized farmers at easy rates. In 1862 he organized a third society at Anhausen which went a step farther, its membership being made up of the borrowing farmers themselves—and thus was developed a rural credit system that has carried aid to millions of farmers and whose boast is that no man ever lost a dollar in a Raiffeisen bank.

We can see the development of the idea—first a charity organization to relieve distress, followed by a philanthropic organization to assist the farmer to get back upon his feet, and then an organization of farmers helping and making themselves independent.

In this country, however, many years after the organization of coöperative societies of the Raiffeisen type in Germany, with the exception of the coffers of the usurers no other banking system for the farmers was known. However, the Philippine Government under the American régime organized the Agricultural Bank, but, though not a total failure it could not be considered a success. With the organization of the Philippine National Bank, the activities of the former Agricultural Bank ceased, and a Department of Agricultural Loans was opened in the Philippine National Bank, which helped big "hacenderos" with large loans.

The small farmers who have no bankable means remained as they were: "They had no credit because they were poor, and they were poor because they had no credit."

In this state of things, our legislators grasped the idea of inserting in our statutes a piece of legislation that in some way or other would help the farmers financially, and with no little difficulty Act No. 2508 was finally enacted in 1915. This is the present Rural Credit Law.

THE RURAL CREDIT ASSOCIATION

The rural credit association is not a new experiment. It has been tried out under varying conditions in different countries. It is discussed under various names, including the Schultze-Delitzsch societies in Germany which were started simultaneously with the Raiffeisen coöperative societies, the Luzzatti and Wollemborg types in Italy, the coöperative banks of Ireland, Austria, France, and Canada.

It not being my purpose to relate the history of rural credit associations, I will simply explain superficially what these associaitons are, where the need for such asociations may be said to exist, what the essential features of the organization are and what advantages the farmer may gain from them.

ITS COÖPERATIVE BASIS

There are many small farmers who realize the importance of improving their equipment and farming methods, but who lack the capital required to make the desired improvement. At the same time the terms on which they may be able to borrow the necessary funds are not such as to encourage them to do so. Their honesty and industry may be unquestioned, nevertheless their individual security does not command the desired confidence. But when a group of neighboring farmers are thus similarly situated, a coöperative rural credit association may supply the needed additional security by placing the collective good will of the group behind each of the members. Hence, it will be seen that a rural credit association is a society of friends and brothers who strive for their common good, a community association whose motto is "one for all and all for one."

It is not an ordinary financial concern, seeking to enrich its members at the expense of the general public. Neither is it a loan company seeking to make profit at the expense of unfor-

tunates who need loans, unemployed laboring men, agriculturists whose fields are suffering from the effects of drought or floods—a company having no mercy for its victims and not hesitating to impoverish them to the extreme limit. The rural credit association is nothing of the kind; it is the expression in the field of economics of a high social ideal. It is based upon the high conception, wholly just, equitable and fruitful, of "union for life" instead of "struggle for life."

Besides coöperation, confidence and mutuality should therefore be the backbone of these associations. Collective good will should be the spirit that ought to predominate in all their undertakings. It is very unfortunate that farmers who suffer from the limitations of their individual personal credit should not take advantage of the benefit of such collective good will. One of the most widespread forms of economic waste among farmers arises from failure to utilize the power of confidence and good will among neighbors. Of course, where conditions are such that neighbors do not trust each other and refuse to cooperate, it is futile to speak of collective power. On the other hand, where farmers are willing to take advantage of the added good will which a neighborly attitude affords, a rural credit association proves a helpful agency in promoting the increase of available capital and in strengthening the borrowing capacity of individuals.

FIRST STEPS TAKEN TO INTRODUCE RURAL CREDIT

The first steps taken toward the establishment of rural credit associations in this country were the organization of agricultural societies throughout the provinces. The object of the organization was that of systematic agricultural education in the principles of coöperation, thus paving the way for the establishment of rural credit and other enterprises of mutual or community value.

A number of years before our Legislature made various attempts to pass a law creating a special type of societies for the promotion of agriculture on a small scale, but these attempts met with no success at all. Then, as before said, Act No. 2508, known as the Rural Credit Law was enacted. This act provided for the organization of associations to be denominated "Agricultural Credit Coöperative Associations" and stated that the purpose should be "to accumulate funds, by means of cooperation, in order to extend to their members credit on reasonable terms for exclusively agricultural operations, and to en-

courage thrift, activity, and punctuality in meeting obligations among members."

The first rural credit society in the Philippine Islands was organized under Act No. 2508, in Cabanatuan, Nueva Ecija, October 19, 1916. Progress since that time has been quite satisfactory, and at the end of December 1926, there were in 42 provinces 544 rural credit associations, with a total membership of 87,535 and a circulating capital of ₱2,570,587.58, distributed among some 29,000 borrowers.

BRIEF SUMMARY OF WORKINGS OF RURAL CREDIT ASSOCIATIONS

Under Act No. 2508 all rural credit organizations must incorporate in accordance with the Philippine Corporation Law, Act No. 1459. There must not be less than five nor more than fifteen incorporators, from whom five directors are selected. The municipal treasurer of the municipality where the association is to be located acts as ex-officio treasurer, without any additional compensation. Shares to the full amount of the capital stock may be sold to any person in the locality who has the reputation of being honest and industrious, and each member of the association is limited to but one vote irrespective of the number of shares he or she holds. Par value of the shares must not exceed ₱5 each, though the usual price of shares in most associations has been placed at ₱2 to make them popular with persons of limited means. The law grants special exemptions and privileges not enjoyed by other corporations.

Once incorporated, an association may engage in the following operations: Extend credit to the members for securing title to and registering their land and for purchasing and securing title to new agricultural land; for the purchase of live stock, fertilizers, preparations for the destruction of pests of various kinds, and for the purchase of seeds, machinery, or implements which the borrower shall use for agricultural purposes exclusively for the redemption of encumbrances on agricultural land; for the cultivation and improvement of such lands; for the expenses in connection with the planting, cultivation, harvesting or care of any agricultural crop or product, or storage and housing until sold or marketed; upon gathered products stored in a safe place and at the disposal of the association, and for the construction, repair and maintenance of irrigation or drainage work. Associations are further authorized to contract loans from the Philippine National Bank and the Insular Gov-

ernment; to acquire or purchase seeds, fertilizers, preparations for the destruction of pests of various kinds, machinery, live stock and agricultural implements of any kind and sell the same to the members of the association.

In practice the application of the machinery of this law is very simple. The money received from the members for the sale of shares or for deposits is given in small sums as loans to those members in need. The directors meet and receive applications for loans. They decide on the merits of each case. The cases of the poorest and most needy who have a legitimate productive use for the money are supposed to be considered first, as the association is limited by law to one municipality. The character and reputation of each applicant is known, and if he furnishes two securities to sign his note to guarantee its prompt payment, the loan is voted.

The law requires that sufficient security be taken for each loan. Three kinds of securities are permitted: personal, chattel mortgage, and real estate mortgage. Associations are advised to make only small loans of ₱100 or less, though larger loans have been authorized for exceptional cases. Loans cannot be made for a longer period than one year, but they may be renewed if in the judgment of the board of directors there is valid reason for so doing. The rate of interest is 10 per cent per annum. Loans may be made only to members of the associations, and every member is required to own at least one share of stock. No director is permitted by law to vote on a loan for himself or for any member of the family. The combined credit of the association serves as an inducement to secure deposits not only from members but from outsiders as well, thus adding a savings-bank feature and also increasing the loaning capacity and working capital of the institution.

The administration and government of these associations are largely in the hands of the members, although there is Government supervision and audit and as a further measure of safety the funds are held by a bonded government official.

These associations represent a simple form of banking. When the people of a community have collected a sum of money by coöperation, they all feel a personal interest in their enterprise and watch the loans made and the security given. The utmost publicity is invited. This stimulates interest and attracts new members; thus the funds and the ability to administer them, advance together. The very struggle at the beginning to secure funds, makes better and more self-reliant members and

promises greater success than if all difficulties and obstacles had been removed by mistaken but well-meaning philanthropists.

A moment's reflection will convince one that these associations appeal to one of the strongest ties that human beings possess—a sense of brotherhood. They do not approach sentimentalism nor, on the other hand, are they so fiercely commercial that they can not be helpful. Careful business rules govern all the transactions, but a man is not made to feel that he has a premeditated idea of not paying his debt when he applies for a loan. He feels a confidence in an institution in which he is a part owner and he will value and respect the membership more and more as his understanding of the plan and its utility is enlarged by experience and observation.

These credit associations are unquestionably training people with limited ability and small means to grow by their own efforts. The plan for advancement and growth is elastic and progress depends upon the coöperation of all. No better system is known to develop self-help, to enable self-respecting people to create a system of finance for themselves without asking or receiving charity or gifts. A great advancement toward our economic independence will be made when the money now taken from the small agriculturist in ruinous interest remains with him through the agency of these rural credit asociations.

Only a start has been made, it is true, but it is a start and a good one, based upon sound economic principles. The smallness of the loans and the limited capital secured may appear to be insignificant to men of large affairs, but it should be remembered that it is just this class of small farmers, small investors, small borrowers, that this system is designed to help. Big business is reasonably well taken care of. The progress made in developing rural credit may appear small, therefore, but it is reaching a class of people that can apparently be reached in no other way, and is aiding them by simply teaching them how to profitably help themselves through coöperation and mutual confidence.

ANSWERING CERTAIN CRITICISMS

That some obstacles are encountered in the management of our agricultural credit coöperative associations is not at all surprising. These exist in every field of human endeavor. It is true in these Islands as elsewhere, because human greed and selfishness run in the veins of mankind the world over. The rural credit associations being a human undertaking, the man-

agement and supervision of which are entrusted to a group of men who are just as human as any other men of whatever color, nationality, and creed, must naturally meet their own obstacles.

The general criticisms which have been uttered in some political circles or launched in the local press are more or less, as follows:

1. That only large proprietors can get loans from the associations;
2. That the intervention of politicians and landlords in the management of the associations is dangerous;
3. That the people have lost their interest in the rural credit work;
4. That the associations are poorly managed and that they are morally and financially a losing proposition;
5. That there are many delinquent borrowers; and
6. That the whole work is a total failure.

That only "large proprietors" can get loans from the rural credit associations is untrue. Out of the 29,000 borrowers, not even 50 can be considered large proprietors in the strictest sense of the appellation given, nor are there 100 borrowers who could each obtain a loan of ₱1,000 in spite of the liberal provision of the Rice and Corn Fund Act, No. 2818, which establishes ₱1,000 as a maximum for individual loans. A farmer who needs ₱100 or ₱500 a year for his agricultural venture can not, under any circumstance, either here or elsewhere, be regarded as a large proprietor. Hence it will be seen that the asseveration that only large proprietors can be benefited by the funds of the rural credit association is too far from being true.

That the intervention of politicians and landlords in the administration is dangerous, is an erroneous conclusion. In this country where political agitation is so intensive that every person and group of persons think they are called upon to partake in all political movements, it would be next to impossible to determine and point a finger at one who is not a politician, if politician means a man who is actively engaged in politics. If he is an influential man in the locality he is either a prospective candidate or a leader of a certain party or at least the head of a dozen electors. If he is an average man in the barrio who seeks to help improve his community by having good roads, markets or schools, he must necessarily be a petty politician who attends political meetings, hear political harangues and then makes his own comment and selection as to the best candidate for whom to vote. But if the critic alludes to the professional politicians or what we call "vividores políticos," I can say that this type of politicians constitute so very insignificant a group that no man of optimistic ideas should be worried thereby.

It is true that in some cases persons holding political positions, otherwise known as "caciques," have used the local rural credit associations to favor their interests, but such cases can not be taken as a general defect of the majority of the rural credit associations. On the contrary in many cases persons holding political positions have helped rural credit associations in such a way that they even confounded this help with their official duties. That some of them have favored their friends and relatives is purely human. It is difficult to expect any one to render more help, when the question of helping comes, to his opponents and detractors, than to his supporters, adherents and kin. This is purely a matter of personal discretion and the effect of democracy.

That the people have lost interest in this patriotic move, is an affirmation that can not be sustained. The statistics show that in 1927 there was an increase of 3,500 in membership, and ₱23,000 in capital stock in the 544 rural credit associations.

That these associations are poorly managed and that they are morally and financially a losing proposition is refuted by proofs taken from the figures shown by the statistics. Any ignoramus in accounting who should happen to look at the balance sheets of these associations, if figures do not lie, would at once be convinced that the operation of these small local banking institutions is a gaining proposition, speaking in plain business language. The total income the year before last was ₱640,158.41, and after they had set aside for the Reserve Fund the sum of ₱11,400.60 and ₱9,423.94 for the dividends account, still there was an undivided profit of ₱702,963.62.

In the twelve years the associations have been operating we have found no need of opening in our books "Profit and Loss Accounts," for the simple reason that they are conducted and managed by public-spirited servants who draw no salary, and that all the income goes to the Profit Account. With rare exceptions, from the presidents of the boards of directors to the treasurers, they receive no remuneration. We are proud to say that not even a single centavo was lost from alleged "maladministration." The only losses which have been sustained have been due to defalcations committed by their treasurers.

It would therefore be more than unjust if the directors who are serving without any pecuniary compensation and have pledged their property to insure the fidelity and conscientiousness of their acts should be drastically dealt with for their minor shortcomings. Allowances ought to be made for them

because of their inexperience and efforts should be made to help them in all their honest endeavors.

That there are many delinquent borrowers in our associations is a fact, but such a state of things in any coöperative movement is also true everywhere. Legal proceedings can be resorted to any time a borrower fails to pay his debt, but in a cooperative asociation, brothers should not hale each other into court if it can be helped. Extrajudicial steps should be resorted to only when the borrowers can not be made to pay their debts in any other way. The association is not after the ruin of any fellow member.

As to the whole work being a total failure, this much can be said: That every new enterprise, plan or invention, has also been considered as a failure at the beginning, but the end is that which gives it due justification.

CONCLUSION

In general, the institution of the rural credit system in the Philippines has brought the common mass to a higher social standard, in that instead of depending on private money lenders they have begun to learn to put part of their income in a coöperative common fund in their locality so they may obtain relief afterwards whenever they are in distress. It is unnecessary to add that the system has been helpful in so far as economic conditions in the localities where agricultural credit coöperative associations exist are concerned, because every little amount given to a real farmer and properly invested in a productive agricultural venture means an increase of production, and consequently an improvement of their "modus vivendi," socially and economically.

It is therefore the paramount concern of every person who has at heart the interest of his fellow citizens to point out to every member of these small local credit institutions in particular and the civic-spirited people in general, their rights and duties to make the rural credit system as successful in these Islands, as it has become in some other countries. Little by little the truth that their salvation lies in their own hands must be instilled into their minds—that it is within their power to oust from their association the undeserving elements and select from among themselves men who they think will work for the general welfare of the community.

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THE WAMPI (WAMPEE)—A VALUABLE FRUIT

By FELIPE PADOLINA
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INTRODUCTION

Since the establishment of the Bureau of Agriculture in the Islands about 25 years ago hundreds of species and varieties of plants have been introduced into the Philippines from different parts of the world. These introductions include fruits, vegetables, forage plants and other species. Some of these plants are very valuable while others are less so; some have proved well adapted to our soil and climatic conditions, and others are less well suited. One of these introductions which has been found to be adapted to the conditions prevailing at the Lamao Experiment Station, Lamao, Bataan, is the wampi. The following is a brief write up on the wampi, its origin, culture and uses.

HISTORY

The wampi, *Clausena wampi—Cookia punctata—Clausena lansium* sk.—*Rata-karapincha* S., is a fruit of Chinese origin and was introduced into the Philippines from India as early as 1912. The tree belongs to the Rutaceae or Citrus family. Two trees were set out at the Lamao Experiment Station, Lamao, Bataan in 1915. One of these fruited for the first time in 1924 but never since.

In 1920, another wampi plant was set out in the field of the same station and it is this tree that bore fruits for the first time from February to May, 1928.

DESCRIPTION

The wampi or wampee is a small tree attaining a height of about 6 or 7 meters, with many of its branches arising from near the surface of the ground. The leaves are impari-pinnate, with alternate leaflets, oblique or unequal at the base, pointed, leathery, dark green to light green in color with yellowish green venations, from 8 to 15 centimeters long and from 4.5 to 8.5 centimeters wide.

The fruits are borne in loose clusters and are arranged like those of the lunao, *Otophora fruticosa* Bl. The pale yellow berries are almost of the same size as grapes, with grayish dots all over rather a rough skin and rounded with a distinct navel. The color of the pulp is almost the same as that of the lanzon and it is divided into 5 or 6 lobes. The fruit is eaten fresh when fully ripe. The clusters of fruits consist of from 10 to 40 berries. The fruits are used as well as the fragrant leaves for flavoring meat curries, etc.

The trees of wampi at Lamao are of two varieties, one producing fruits which are slightly acidic and with seeds, and the other sweet and seedless ones. A tree is also growing in our Demonstration Station at Lipa, Batangas, and is said to be bearing sour fruits with seeds.

SOIL AND CLIMATIC REQUIREMENTS

The wampi is said to thrive in a mixture of loam and peat in humid districts at medium elevations. Under Lamao conditions the trees seem to do well in sandy loam with but little care. In fact the existing trees, including the small ones, at Lamao are growing vigorously and two of them bore fruits after 9 and 7 years, respectively, in spite of the dryness of the place. The tree is worth while cultivating and it is expected that the seedless fruit variety may find a good market in the Islands like the grape.

PROPAGATION

The wampi is said to be propagated by seeds. At Lamao, cuttings of second-growth wood of wampi without leaves have successfully rooted when planted in a mixture of sand, compost and ordinary soil, placed under a nursery shed in a plot or bed. The wampi can be propagated also by grafting, budding, and marcotting without difficulty. Plates XLIX, L, and LI show the results of the newly tried methods of propagating this plant with 66, 75, and 100 per cent success, respectively, for each of the aforementioned methods of vegetative propagation. Marcotting takes only about two months up to the time of separating the rooted branch from the tree.

PLANTING DIRECTIONS

In planting wampi, holes about 60 cubic centimeters deep 6 to 8 meters apart should be dug, and the seedlings or plants planted not deeper than they were planted in the nursery bed or bamboo tubes or pots. If the plants are in bamboo tubes,

simply split each tube longitudinally into halves leaving one half in the hole so as not to disturb the roots. If the plants are planted in beds, care should be taken to cut off the injured or broken roots before planting. The hole in which the plant is to be planted should be filled with rich, mellow, well-drained soil whenever possible. The soil in the hole should be made compact enough so as not to leave any air space or vacuum around the roots of the plant and no depression left around the base of the plant in which water will stand after watering.

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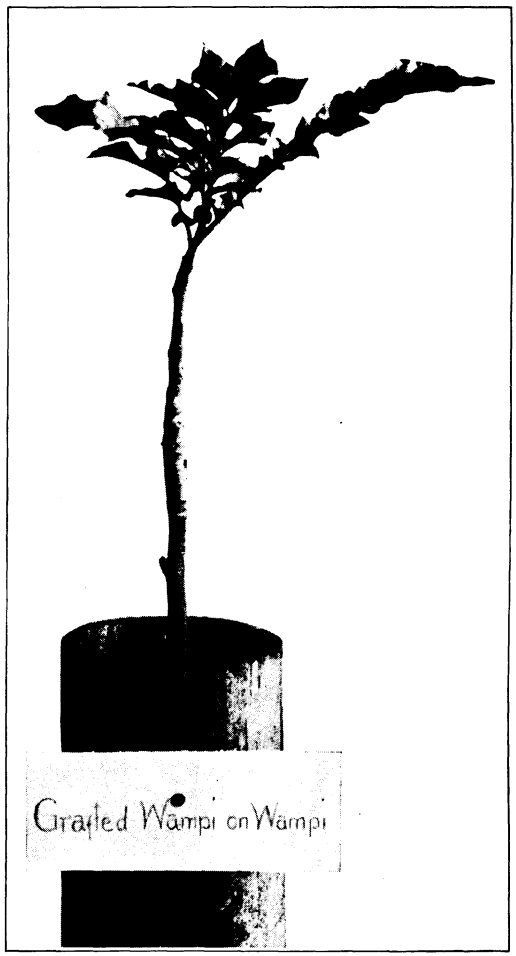
Wampi, *Clausena wampi* showing a bunch of fruits



Wampi grafted on wampi

Wampi budded on wampi

Marcotted wampi

OBSERVATIONS ON THE TEA INDUSTRY OF JAVA AND INDO-CHINA

By F. G. GALANG
Horticulturist

PREPARATION

In Indo-China the natives prepare the tea as follows: The branches and leaves, irrespective of their sizes, are chopped into small pieces and are pounded in wooden mortars with hot water, then placed in earthen pots or jars for two days to ferment before being dried in the sun. A very poor quality of tea is produced by this method and this is used only by the natives.

In Java at the Goalpara Tea Estate tea is prepared as follows:

1. Only the first or at most four young and opened leaves are picked during the day—usually between 6.30 and 3 o'clock. Old leaves harvested by mistake are picked out by women. These young leaves are spread thin—from 3 to 4 centimeters or 3½ pounds to the square meter—on netted wire shelves to wilt overnight and are crushed and prepared the following morning, but sometimes withering takes place from 18 to 24 hours. The wilting racks, placed 15 centimeters one above the other, are provided with ventilating windows to regulate the temperature. Room temperature is maintained during the wilting process. Care is taken to let the leaves wilt just enough—not too much nor too little—as otherwise the quality of the tea produced is poor. If the atmosphere is too cool the windows are opened to admit hot air from the engines and if too warm they are closed.

2. The wilted leaves are then crushed by means of rollers that revolve under their own weight in order not to break the plant cells but the leaves are sufficiently broken to remove the water or sap from them and thus better fermentation is obtained. The leaves are placed in vacuums below the rollers. The crushing of the wilted leaves is done as follows:

a. For 15 minutes the rollers are allowed to revolve with practically no pressure, so as not to break the leaves.

b. For 5 minutes with a very light pressure—enough to crush the leaves.

c. For 10 minutes with a rather heavy pressure—enough to extract the sap or water from the leaves.

3. During the first machining the leaves are turned into balls and these are passed through the so-called ball-breaker where they are broken up into smaller pieces. The ball-breaker is a sort of a revolving machine which is capable of breaking the balls of leaves. The broken balls are then sieved in order to secure better fermentation—smaller leaves will ferment faster than the coarser ones. The sieve is of one-third of an inch mesh and 9 meshes to the square inch, and is adjusted so as to have the coarse leaves fall to one end and the fine ones passed through the sieve.

4. Properly sieved leaves are now fermented in the fermenting racks, piled about two inches thick on each of the fermenting trays, which are made of wooden frames with netted wire flooring, and so arranged as to permit the free access of air. Each tray has a capacity of 60 to 70 pounds of tea leaves. To obtain a better quality of tea the coarse leaves are fermented separately from the fine ones. The latter will take about $1\frac{1}{2}$ hours and the coarse leaves $2\frac{1}{2}$ hours to ferment.

5. *Drying.*—The "Sicocco dryer" with a capacity of 350 pounds per hour is employed in this estate. It consists of a big chamber with a revolving fan to regulate the temperature, and eight drying trays arranged in such a way that during its operation the tea drops from the uppermost tray to the next lower one and so on until reaching the bottom tray, where there is an outlet for the dried tea, which process takes about 15 to 20 minutes. The lower tray usually gets the hottest air during the course of drying. The hot air is furnished by an engine outside and enters through one of its bottom corners. The temperature of the dryer is kept at 80 to 90° C, and this is indicated by a thermograph with curves drawn as the heat is fed to the dryer. A hotter temperature than this will burn the tea. The feeding of the dryer is done by one man at the top where the fermented leaves are being spread evenly by the operator as he feeds the dryer. A loss of about 30 per cent moisture from the leaves has been recorded after drying the tea from the fermentation racks.

6. Sorting is done as follows:

a. The dried tea is broken up by an apparatus called the cutter, which makes about 30 revolutions per minute. The broken tea falls off into the revolving and rounded sieve with 14, 8, 6, and 5 meshes to the square

inch arranged one below the other. These successive sieves are slightly inclined in order that the tea will fall to the bottom without any difficulty. Each of the sieves is provided with parallel wooden braces and an iron bar for support.

b. Coarse tea that has escaped from the first operation is again cut and sieved as previously.

c. The dust and the finest tea leaves are then sifted in the "Jackson" sifting machine, and those that have escaped from this machine are worked out in the native system similar to that used in the Philippines in removing the tiki-tiki and rice hull of palay. The bamboo "bitchays" employed are of various meshes.

d. All leaf stalks are picked by hand from the different grades. This is done by women, and each woman is able to clean 10 to 15 pounds of tea in a day.

e. The finished tea is graded by the company as follows:

1. Orange Pecco (OP)
2. Broken or Pecco (BOP)
   - *a*. BOP No. 1
   - *b*. BOP No. 2
3. Broken Pecco (BP)
   - *a*. Br T No. 1
   - *b*. Br T No. 2
4. Pecco Souchong (PS)
5. Fannings (PF)
6. Dust (D)
   - *a*. D No. 1
   - *b*. D No. 2

When tea brings good prices grades 2, 3, and 6 are not divided into (*a*) and (*b*) but sold only as one class.

7. *Packing.*—All properly graded teas are placed in a tea chest compartment lined with tin and this compartment is divided into as many divisions as there are classified grades of tea. The finished product of each grade is stored in the room or division where it belongs. Each of the divisions is provided with a hole at the bottom for the tea to pass through when ready for packing.

Tea is packed either in cases, paper or aluminum-foil with tissue paper inside. The six different grades are packed in boxes as follows:

Grade No. 1	80 lbs. net
Grade No. 2	85–90 lbs. net
Grade No. 3	90 lbs. net
Grade No. 4	in packets of 1, 1/2, 1/4 and 1/10 lb. (aluminum-foil with tissue paper inside)
Grade No. 5	100 lbs. net
Grade No. 6	110 lbs. net

The boxes are somewhat loosely filled only and not tightly packed so as not to break the tea while in transit. To effect this the boxes filled with tea of different grades are put at the top of a machine where they are shaken so as to settle the contents by their own weight and not break the tea, which would injure its quality.

Care is taken to mix the product of each grade before packing in order to produce a uniform and standard product for the market. It has been discovered that tea produced one day is somewhat different in appearance from that produced another day. The mixing is done in canvas by hand.

Green tea.—Green tea is prepared by steaming the green leaves, instead of withering, and by omitting the fermenting process. The green teas are graded into young hyson, hyson No. 1 and 2, gunpowder and dust.

CULTURE

Tea is cultivated and found growing well even at low elevations with an evenly distributed rainfall of from 100 to 150 inches a year, but it is said that at lower altitudes the quality of the product is inferior. It is said that 4,000 to 7,000 feet is the best elevation for this plant. The Goalpara Tea Estate has an elevation of 3,600 to 4,500 feet above sea level. At lower elevations tea is grown under the shade of leguminous trees.

Planting is done by stake or stump and plants are distanced 8 feet between the rows and 6 feet between the plants in the rows, and are only allowed to grow 4 to 5 feet high. To induce the growth of the young shoots and to obtain the maximum quantity of the best quality of leaves regular pruning is practised on old plantations every $1\frac{1}{2}$ to 4 years, when the plants are reduced to about $2\frac{1}{2}$ or 3 feet in height, but the frequency of pruning varies much with the elevation, soil, variety, cultivation and the manner of plucking the leaves. The old as well as the young branches are removed and the top of the tea plant is made as level as possible by "tipping" or breaking the tips of the primary shoots. Every time pruning is done the ground is changkolled in alternate rows.

Helopeltis is so far the most dangerous insect found to attack the tea leaves. This insect is picked off by hand and no spraying has yet been found practicable to kill this pest. The tea tortrix, and shot-hole borer do a certain amount of damage in Ceylon. No serious diseases are found affecting the tea plant

except the root disease but this is under control in Ceylon. Leaf diseases are known but these are not of much importance.

Harvesting commences when the plants are about 2 years old or when they have made a growth of about 2½ feet. Picking is done every ten days, and as a general rule only the first three or four opened leaves are picked for tea production. A woman can pick an average of 40 pounds of fresh leaves in 4½ hours. Tea produced from the old leaves sells at a very low price because of its poor flavor. The old leaves have a very strong taste, which is also objectionable.

The data given the writer on the production per bouw [1] at the Goalpara Tea Estate are as follows:

Year	Yield in pounds		Year	Yield in pounds	
	1910 planting	1892 planting		1910 planting	1892 planting
1913	168	493	1920	467	1,109
1914	430	935	1921	412	883
1915	449	1,098	1922	360	1,132
1916	472	1,190	1923	655	1,308
1917	535	1,330	1924	719	1,403
1918	707	1,195	1925	812	1,383
1919	728	1,230			

The low yield obtained in 1921 was due to diseases.

The yields in other plantations ranged from 300 to 1,200 pounds per acre. A yield of 600 to 700 pounds is considered good yield.

The full production of tea is attained at the age of 8 years.

At the Goalpara Tea Estate tea plants about 32 years old were fertilized for the first time only about 7 years ago. Two hundred ten kilos of ammonium sulphate and 860 kilos of copra cake applied singly per bouw have been found to be the best fertilizers there when the application is made around the plants.

Green manuring is done very extensively on tea plantations in Java. This is accomplished by cutting off the small branches of leguminous trees or bushes planted between the tea plants, chopping them small and burying them in the ground between the tea. *Albizzia moluccana, Deguelia microphylla,* and ipil-ipil are commonly used.

Figures on the cost of field operation at the Goalpara Tea Estate are as follows in guilders or florins:

1. Felling, burning and planting, F250 per bouw.
2. Cultivating young field, F50 per bouw and F25–F30 for old field.

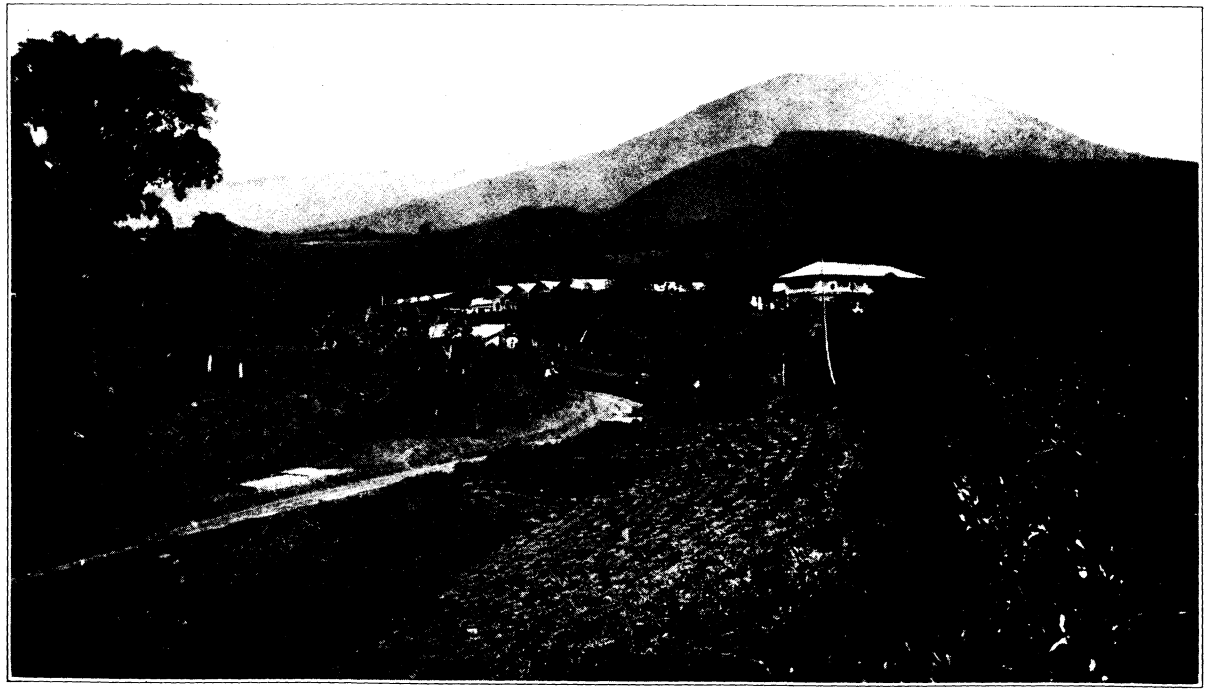
[1] Note: 1 bouw equals 0.7096 hectare.

3. Changkolling, F20 per bouw including the digging of catch drains 2 feet deep.

4. For picking one pound of fresh leaves, F0.11.

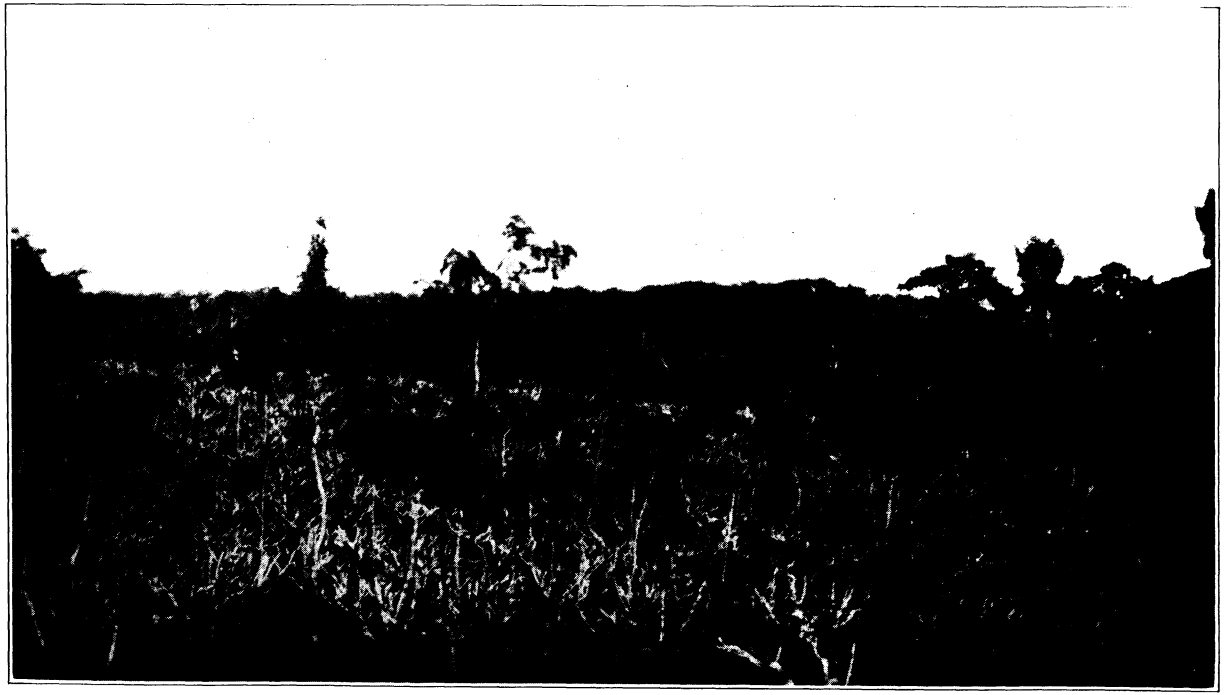
The capital cost per acre of other tea estates in Ceylon ranged from ₱339.50 to ₱970 during the first five years, with a greater cost for the first four years. This includes machinery, cost of its installation, etc. A good tea estate can realize from ₱2,182.50 to ₱2,910 per acre.

Note: F1.00=₱0.80. 1 Acre=0.4047 hectare
G1=₱0.97 1 Bouw=0.7096 hectare



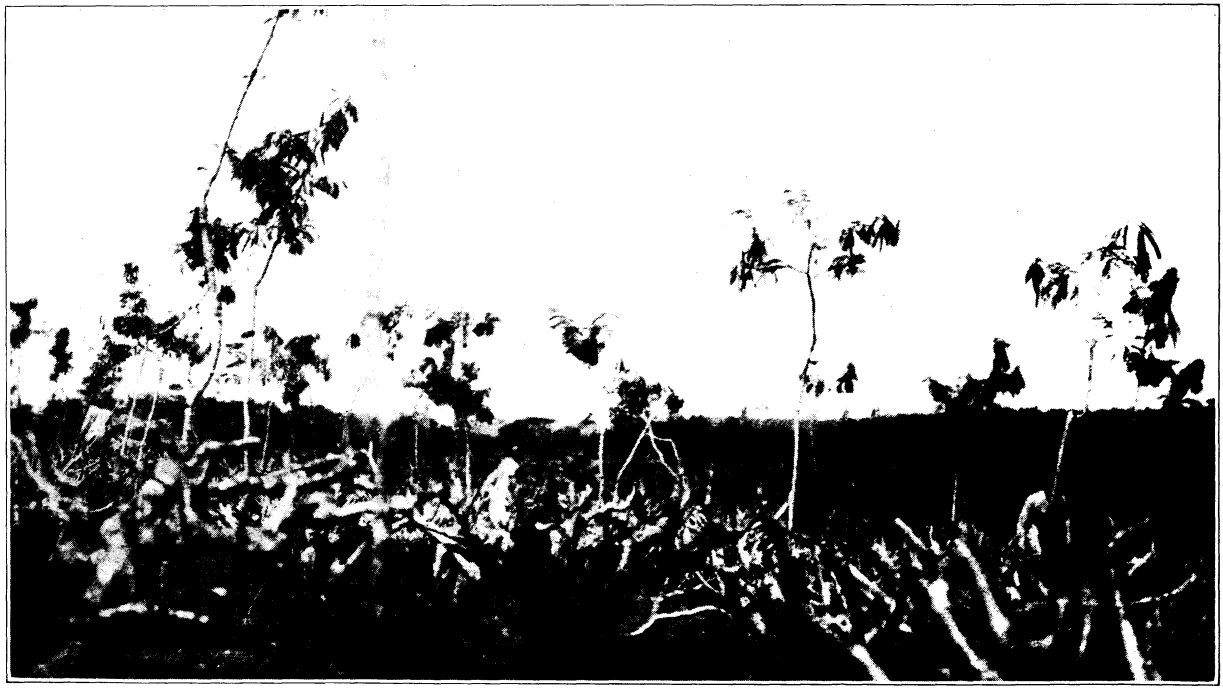
General view of the Goalpara Tea Estate, Java

Partial view of a tea plantation. Siantac, Sumatra



Pruned tea plants with legumes between the rows for green manuring purposes, Goalpara Tea Estate, Java

Fertilizing tea plants after they have been pruned



Changkolling a tea plantation after pruning, Goalpara Tea Estate, Java

NOTES—FOURTH QUARTER

OUR NEW UNDER SECRETARY

"Let George do it" must be the favorite dictum of the powers that be when they are in a quandary as to who should hold a certain position in need of a trustworthy occupant. For "George" Vargas, as he used to be known in his college days, has held almost every executive position available and vacated, since he entered the Government service. Vargas was not the original George but he answer well to that name.

Since his school days he has been in one way or another a regular headliner. In college he was more than once a headliner, as when he wrote a plain but forceful article on the "Philosophy of the Filipino Farmer" in the College Folio, which was honored by (adverse) editorial comments in the local papers, for it was too forceful and faithful a picture of peasant life as he saw it; and at his last graduation when he emerged a valedictorian with a prize thesis.

His public service began with an appointment as a law clerk of the Philippine Commission. Next he was taken as the Legislative Secretary of Speaker Osmeña. Then he served as Executive Secretary of the First Philippine Independence Mission, in 1919, and in the same capacity in 1922. During the war he enlisted and became a major in the National Guard. Thereafter he was appointed Assistant Director of Commerce and Industry and later was, for a brief period, Acting Director of Posts. And finally he was made Director of the Bureau of Lands.

Outside of the Government offices, he has been equally in demand, in the field of sports and in the clubs—a popular sportsman and clubman.

Thus the new Under Secretary brings to his new position a wealth of experience as an all-around executive, remarkable for one of his youth and initial training. A home product of the public school and of the University of the Philippines, tempered in the Government service, and having the vision and elan of youth it seems certain that, he will accomplish what is expected

of him as the right-hand man of the Secretary of the Department of Agriculture and Natural Resources.

It seems a far cry from his law training and his executive experiences, to his new assigned task, but he is there on his native heath, in his boyhood environment, for he was born and raised on a farm and did his turn at the plow in the family hacienda. His father's improvement on the old wooden plow—the Vargas (Iron) Plow—might well be the principal device on the family coat of arms. * * * In entering on his new position one might say he was going back to the farm to improve on the old man's work.

J. Q. D.

FROM OUR CONTEMPORARIES

The proposed international conference of representatives of sugar exporting countries which was to have been held in Berlin in October 1928, has been postponed indefinitely. The indifference of Java to the program for international control of sugar exports caused the abandonment of the project. At the beginning high hopes for success were predicated upon adherence to the plan by Cuba, Java, Czechoslovakia, Germany, and Poland, the principal exporting countries. The European members of the conference—Germany, Czechoslovakia, and Poland—propose to maintain an international committee as an agency to promote the use of sugar.—*Facts About Sugar.*

It has been found that budgrafting will not always result in the transmission of the high yielding qualities of rubber trees; that grafted trees (in Malaya) are more susceptible to diseases than seedlings.—*Tropical Agriculture.*

The introduction and propagation of improved varieties of sugar cane has resulted in the lowering of costs of production in Java. It is stated that, with one-half of Java's sugar-cane crop made up of the variety P. O. J. 2878, the cost of its manufacture into sugar has been reduced by $\frac{1}{4}$ cent per pound. The heavier yield of this cane per unit area and the attendant economies in its handling both in the field and in the factory all account for this reduction in costs.—*The Planter and Sugar Manufacturer.*

After three months of exploration—search into the wilds of New Guinea and Papua for native and primitive varieties of sugar cane which might prove immune or resistant to the diseases and pests of the cultivated plant, Dr. E. W. Brandes of the U. S. Department of Agriculture, who headed a party of four for the purpose, reports a collection of 167 varieties. In this collection is a new species of sugar cane which produces hard, straight canes growing to a height of nearly 33 feet.—*Facts About Sugar.*

The Imperial Bureau of Entomology of Great Britain has established a "Parasite Zoo" where parasitic enemies of certain types of insects, both actual and potential, are bred.—*Tropical Life.*

BOOK REVIEW

BARRETT, OTIS WARREN. The Tropical Crops. (The Rural Science Series.) 445 pp. The Macmillan Company. New York, 1928.

"A cross between a manual and a reference book" . . ."a popular treatment of agriculture in tropical regions with a discussion of cropping systems and methods of growing the leading products," written by the Agricultural Director of the Department of Agriculture and Labor of Porto Rico, "who has had an exceptional opportunity to gain first-hand information on practically all of the crops grown in the tropics of both hemispheres."

Subjects treated of: Tropical Field Practices and Conditions Geography and Climate of Tropical Regions; Living Conditions for the Tropical Planter; Coffee; Cacao; Tea; Sugar Cane; The Citrus Fruits; The Pineapple; The Bananas; Other Tropical Fruits; The Coconut; The Oil Palm; Other Palm Products; Rubber; Other Tree Products; The Tropical Fibers; Grains and Forage; The Root Crops; Tobacco; Beverages and Masticatories; Spices; and Miscellaneous Crops.

To the Philippine farmer and industrialist, it presents a bird's-eye survey of the wide field of tropical agriculture in both hemispheres, as well as timely suggestions regarding the "dangers ahead of coffee and cacao raising, recent mistakes with coconuts and new ideas in rubber cultivation."

Each plant is dealt with in readable style, its origin, history, varieties, pests, diseases, economic status, field practices, harvesting, marketing and prospects, being given. The generous reference to Philippine crops and conditions should be of special interest to the Filipino farmer.—J. Q. D.

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[1] ₱1 Philippine currency equals $0.50 United States currency.

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